# EVALUATION OF TREATMENT MODALITIES AND ITS COMPLICATIONS IN THE MANAGEMENT OF ZYGOMATIC COMPLEX FRACTURES

*Dissertation submitted to*

**THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**

*In partial fulfillment for the Degree of*

**MASTER OF DENTAL SURGERY**

**BRANCH III**

**ORAL AND MAXILLOFACIAL SURGERY**

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# CERTIFICATE

This is to certify that the dissertation titled "**EVALUATION OF TREATMENT MODALITIES AND ITS COMPLICATIONS IN THE MANAGEMENT OF ZYGOMATIC COMPLEX FRACTURES**" is a bonafide record of work done by **Dr. NAVEENA.R.** Under my guidance during her postgraduate study period between **2010–2013.**

This dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY,** in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY** in **Branch III – Oral and Maxillofacial Surgery.**

It has not been submitted (partially or fully) for the award of any other degree or diploma. It has neither been published in any journal nor presented anywhere.

| **H.O.D & Guide** | **Principal** |
|---|---|
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Date :

Place : Coimbatore.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| ZMC # | Zygomatico Maxillary Complex fracture |
| RTA | Road Traffic Accidents |
| CT | Computed Tomogram |
| HIV | Human Immuno Deficiency Virus |
| Hbs Ag | Hepatitis B Antigen |
| ECG | Electro Cardio Gram |
| PNS | Para nasal sinus view |
| SMV | Submento vertex view |
| TMJ | Temporomandibular Joint |
| OPG | Orthopantomogram |
| FZ | Fronto Zygomatic |
| IO | Infra Orbital |
| ZMB | Zygomatico Maxillary Buttress |
| Zyg. Arch | Zygomatic Arch |

## ABSTRACT

**AIM:**

The aim of this study is to evaluate the type of Zygomatic Complex fractures as classified by Markus Zingg as Type A, Type B and Type C and to arrive at a consensus as to which treatment modality is most appropriate for each type of fractures.

**METHODOLOGY:**

A retrospective study that included 22 patients with unilateral fractures of Zygomatico-maxillary complex treated by direct and indirect reduction methods with or without internal fixation using trans osseous wires or mini plates and screws. A thorough clinical and radiographic pre-operative assessment was made for the fracture of zygomatico maxillary complex with good quality photographs, Computed Tomography and/or Para nasal sinus view and a Submentovertex view. Post-operative radiographs were taken within 36 hours post operatively to assess for the adequacy of reduction and at the 5$^{th}$ postoperative week to assess for the adequacy of fixation. Radiographic parameters assessed were orbital size, contour of the zygomatico-maxillary buttress, alignment of the infra-orbital rim and approximation of fronto-zygomatic suture, projection of the malar buttress and contour of the zygomatic arch. Clinical parameters assessed were facial symmetry, mouth

opening, occlusal disturbances, infra orbital nerve paresthesia and orbital complications.

**RESULTS:**

4 out of 22 cases (18.18%) were treated by indirect surgical reduction. The other 18 cases (81.81%) were treated with direct reduction and fixation of ZMC. 7 cases had one point fixation (31.81%), 8 cases had 2 point fixation (36.36%) and 3 cases had 3 point fixation (13.63%). In total, 3 cases (13.63%) showed inadequate reduction, [1 case of direct reduction and 3 point fixation (Type C fracture) with miniplates at Frontozygomatic region & Zygomaticomaxillary Buttress and wiring at Zygomatic Arch and 2 cases of indirect reduction without fixation (Type A fracture)] and 3 cases (16.66%) showed inadequate stability [first case (Type B fracture) with one point fixation, second case (Type C fracture) with 2 points fixation and the third case (Type C fracture) with three points fixation of which two points fixed with miniplates and one point with wires]. The rest of the cases (n=15, 83.33%) showed good reduction and stability. One case presented with ectropion and increased scleral show of 1mm post operatively, but did not require any corrective surgery and one case had infected plate removal in the region of Frontozygomatic region at the second postoperative month. All cases that presented with infra orbital paresthesia and reduced mouth opening after trauma were relieved of the symptoms post operatively.

**CONCLUSION:**

Out of our experience, we recommend single point fixation at Zygomaticomaxillary Buttress region for Type A fractures, two points fixation at Zygomaticomaxillary Buttress and Frontozygomatic region for Type B fractures and three points fixation at Zygomaticomaxillary Buttress, Frontozygomatic region and Infraorbital region for Type C fractures.

**KEY WORDS:**

Zygomatic complex fractures, Markus Zingg classification, Fronto-zygomatic suture, Infraorbital region, Zygomatico-maxillary buttress, Paranasal sinus view, Submentovertex view.`

# INTRODUCTION

Surgical management protocol of facial trauma has undergone a revolution in the past decades because of the introduction of better diagnostic tools, improved surgical approaches and availability of improvised fixation techniques. Along with these technical and surgical advances, in depth understanding of the pathophysiology of fracture plays an important role in the management of these facial fractures.

Orofacial injuries produce psychological, physical & economical consequences of great importance to the patient. Because of these considerations, the surgeon must direct his efforts towards the restoration of aesthetic & function as expeditiously as possible. Thus it suggests the absolute necessity for careful evaluation of the patient & the type of procedure to suit the needs of each individual.

The Zygomatic bone is the principle buttress which transmits forces from the maxilla to the cranial vault. The zygomatic bone is an important anatomical structure that helps to form the lateral and inferior wall of the orbit. The convex shape of the zygoma, which gives the malar prominence, makes this area of mid face vulnerable to injury.[22]

The zygomatic complex is a compact bone firmly attached to the maxilla but with weak attachments to the frontal and temporal bone. It is more vulnerable to fracture due to the craniofacial growth, texture of bone and the presence of maxillary sinus. So any physical injury to the side of the face may result in disruption of the frontozygomatic suture and fracture of the zygomatic arch and infra orbital margin. The malar prominence is usually pushed inwards and downwards by the kinetic force. However the type, direction and the amount of the kinetic energy exerted on the zygomatic complex will decide the severance of the fracture (displacement and communition).

Zygomatico-maxillary complex fractures are the most common maxillofacial fractures next to mandibular fractures and nasal bone fractures. Displaced Zygomatic bones are easily overlooked after an accident due to swelling and ecchymosis of the overlying tissues.[22]

Tentative diagnosis is based on the clinical findings (inspection & palpation) & confirmatory diagnosis is based on the radiographs. The assessment of the treatment of zygomatic complex fractures is done by three main visualization methods such as Computed Tomography, Photographs, and Radiographs. The gold standard for assessment of ZMC is by the use of CT. Photographs include frontal, three-quarter, birds & worm’s eye views are good for assessing facial symmetry.[18]

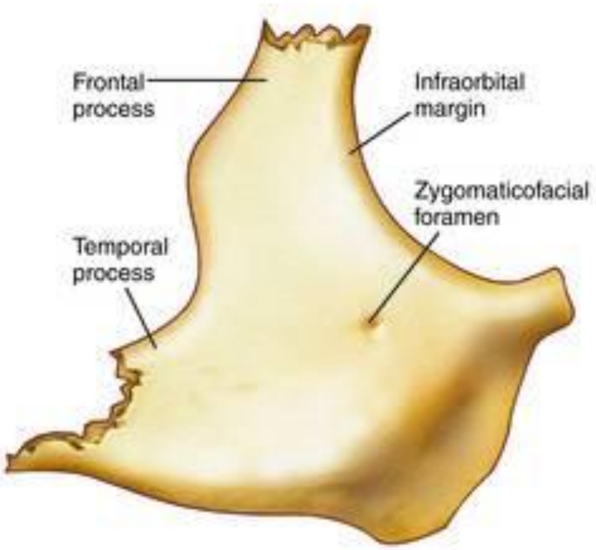
Fractures of the Zygomatic complex are not difficult to correct but unfortunately are complicated by delay in diagnosis and initiation of treatment. Treatment ranges from keeping the patients under observation, initiating reduction with fixation if necessary, or routine exposure and fixation of at least 3 or 4 articulations.[18] The primary treatment and immediate post-operative results has been the subject of more severe investigation. **Knight and North**[45] related the postoperative results of management to the type of fracture. They found closed method of repositioning unsatisfactory for some type of fractures. Open reduction and fixation was suggested by Dingman as the treatment of choice when displaced fractures. Precise reduction is essential to prevent residual facial asymmetry, trismus, diplopia and enophthalmos. Contemporary treatment with open reduction and three point fixation is mandatory for fractures of zygoma associated with displacement.

The review of literature is replete with various treatment modalities but no consensus has been reached as to which treatment modality is appropriate. Hence this study was conducted in a genuine manner to classify the zygomatic fractures according to ***Markus Zingg***[51] and evaluate various treatment modalities and their comparison with certain parameters to arrive at a consensus as to which modality is appropriate.

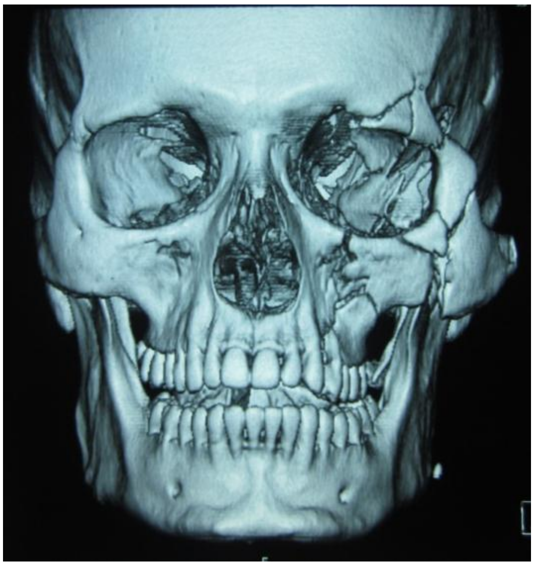
## SURGICAL ANATOMY

The key to the proper understanding of the nature and treatment of the fractures occurring in the middle third of the face lies in thorough knowledge and appreciation of the surgical anatomy of the region.

The zygoma has four projections, which create a quadrangular shape: the frontal, temporal, maxillary and the infraorbital rim. The zygoma articulates with four bones: the frontal, temporal, maxilla and the sphenoid. A zygomatic complex fracture includes disruption of the four articulating sutures: zygomatico-frontal, zygomatico-temporal, zygomatico-maxillary and the zygomatico- sphenoid sutures.[22]




All zygomatic complex fractures involve the orbital floor and therefore an understanding of orbital anatomic features is essential for those treating these injuries. The orbit is a quadrilateral pyramid that is based anteriorly. The orbital floor slopes inferiorly and is the shortest of the orbital walls, averaging 47 mm. It is composed of the orbital plate of the maxilla, the orbital surface of the zygomatic bone, and the orbital process of the palatine bone.



The medial and lateral walls converge posteriorly at the orbital apex. The medial wall consists of the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoid, and a small portion of the sphenoid body. The lateral orbital wall is the thickest and is formed by the zygoma and the greater wing of the sphenoid.

The orbital roof is composed of the frontal bone and lesser wing of the sphenoid.

The zygomatic arch includes the temporal process of the zygoma and the zygomatic process of the temporal bone. The glenoid fossa and articular eminence are located at the posterior aspect of the zygomatic process of the temporal bone.

The sensory nerve associated with the zygoma is the second division of the trigeminal nerve. The zygomatic, facial and temporal branches exit the zygomatico facial and zygomatico temporal foramina in the body of the zygoma and supply sensation to the cheek and anterior temporal region. The infraorbital nerve passes through the orbital floor and exits at the infraorbital foramen. It provides sensation to the anterior cheek, lateral nose, upper lip, and maxillary anterior teeth. Muscles of facial expression originating from the zygoma include the zygomaticus major and labii superioris. They are innervated by cranial nerve VII. The masseter muscle inserts along the temporal surface of the zygoma and arch and is innervated by a branch of the mandibular nerve.

The Zygoma provides an origin to a major portion of the masseter muscle along the body and temporal process.[22] In addition, the temporal fascia also attaches along the arch and posterolateral edge of the temporal process. The fascia produces resistance to inferior displacement of a fractured fragment by the downward pull of the masseter muscle. The zygoma also provides attachments for the temporal and zygomatic muscles. The strong infra orbital and lateral rim provides protection to the globe.

The position of the globe in relation to the horizontal axis is maintained by Suspensory ligament of Lockwood. This attaches medially to the posterior aspect of the lacrimal bone and laterally to the orbital (Whitnall’s) tubercle, which is 1 cm below the zygomatico-frontal suture on the medial aspect of the frontal process of the zygoma. The shape and location of the medial and lateral canthi of the eyelid are maintained by the canthal tendons. The lateral canthal tendon is attached to Whitnall's tubercle. The medial canthal tendon is attached to the anterior and posterior lacrimal crests. Zygomatic complex fractures are often accompanied by an anti mongoloid (downward) cant of the lateral canthal region caused by displacement of the zygoma.

# AIMS AND OBJECTIVES

There are various treatment modalities for treating different types of zygomatic complex fractures but there is no consensus as to which treatment modality is most appropriate for what type of fractures. The aim of this study is to arrive at such a consensus.

There are various classifications for zygomatic complex fractures which are described in detail in the review of literature. The classification that is followed in our study was proposed by ***Markus Zingg*** [51] as follows:

Type A : Incomplete zygomatic complex fracture. This may be an isolated zygomatic arch fracture ($A_1$) lateral wall fracture ($A_2$) or an infra – orbital rim fracture ($A_3$)

Type B : Complete mono fragment zygoma fracture (Tetrapod Fracture)

Type C : Multi fragment zygoma fracture, same as Type B with fragmentation including body of the zygoma

The objective of the study is to evaluate the type of fractures treat them accordingly. Later the patients are followed post operatively and analyzed based on the following parameters.

1. Mouth opening.
2. Facial symmetry.
3. Infra orbital region paresthesia.
4. Adequacy of reduction.
5. Adequacy of fixation.
6. Associated complications.

# REVIEW OF LITERATURE

**Jackson et al (1956)**[78] described a Balloon technique for the treatment of fractures of the zygomatic bone using a Shea Anthony Balloon through nasal antrostomy. He stated that comminuted fractures were easily reduced and air pressure is easily controlled and regulated. This technique can also be used in conjunction with Gillies, hook or external traction method.

A variation of this procedure was described by **Jarabak (1959)**[31] who employed a Foley's catheter inserted by the oro-antral approach. Gutman. D used this technique among his patients and found good results.

**Knight and North (1961)**[45] classified the fractures of the zygomatic complex and arch based on the anatomy of the fracture, which had been found to be helpful in predicting the clinical features and necessary treatment. He concluded that arch fractures and laterally rotated body fractures were well stable, medially rotated fractures were all unstable and required an antral pack, in unrotated body fractures 60 percent were stable and 40 percent were unstable. Complex fractures were 30 percent stable and 70 percent unstable and in these cases direct wiring or external fixation was often required. Malar fractures in those under 21 years old and in females were appreciably more likely to be unstable. Diplopia was commonest when there was displacement both in the floor and in the lateral wall of the orbit and trismus was commonest in arch fractures and to a lesser extent in rotated body fractures.

**H.S. Samuels (1970)**[28] reported the use of Krischner's wire in facial fractures, after satisfactory elevation with a percutaneous hook. The Krischner's wire was passed from the stable uninjured zygoma to the stabilized zygoma on the injured side, through the nose and antrum. This avoided open reduction, provided immediate rigid fixation and shortened hospitalization.

**Zigmunt. W. Pozatek et al (1973)**[67] suggested the use of a lateral eyebrow approach, for elevation / reduction of the fractured zygoma and subsequent stabilization through transosseous wiring at the fronto zygomatic region. They also pointed out certain advantages of this method in that it provided for direct visualization of fracture, its anatomic reduction and stabilization.

**Podoshin. L (1974)**[66] reported a method for reduction of the fractured zygomatic arch by the use of Foley’s catheter, the balloon of which is filled with a contrast medium, that aids in better control over placement and position of the fractured parts of the arch.

**David Poswillo (1976)**[12] described application of a specially designed traction hook as a technique for the simple, speedy and effective reduction of the large majorities of the fracture of malar complex by direct extra oral approach. They found the method unsuitable for comminuted fracture and for those fractures where severe dislodgement had occurred in an upward and inward direction with resultant overlapping of the frontal and malar pillars.

**Duckert et al (1977)**[16] recommended a suspension bar fashioned from dental compounds as an external fixation device for the treatment of comminuted unstable zygoma fractures, where the conventional means of stabilization had proved undesirable and where passive fixation was desirable.

**James H. Quinn (1977)**[33] suggested a lateral coronoid approach through an incision situated over the anterior border of ramus. Supra periosteal dissection was carried out following the lateral aspect of the coronoid process, to reach the medial aspect of the arch. This method obviated the potential difficulty of coronoid interposition and elevation of an isolated fragment encountered with the use of the Keen's approach.

**Ronald S. Matsunaga (1977)**[71] gave a simple protocol for treatment of malar fractures, in which the zygoma was reduced by Gillies method. Fixation was achieved by an internal wire pin, which would fixate the tripod malar fracture fragment eccentric to the axis of hinging forces. The method used had less associated intra operative morbidity and complications.

**Vance, Robideauex (1978)**[7] reported Oculo Cardiac reflex that occurred during mid face disimpaction. During reduction, the retro displaced midface was pulled anteriorly, putting traction on the floor and medial aspect of the orbit as well as the maxilla. This, in turn, undoubtedly put tension on the orbital contents and stimulated the terminal branches of the trigeminal nerve, which was the afferent limb of the oculocardiac reflex.

**J.M. Gorman (1979-80)**[37] described a technique for the stabilization of some malar fracture by means of silicone elastomer wedges. After reduction the unstable zygoma was stabilized with the wedge, inserted in the malar buttress. Its removal was carried out after 6 months under local anesthesia. The dual external and internal approach was a possible disadvantage as was the need to go back later to remove the silicone.

**Karel G.H. Vanderwal et al (1981)**[40] used a modified oral airway in the fixation of an unstable zygomatic arch fracture. The arch was reduced and repositioned using a Bristow elevator. If fragments do not stay in position after reduction, a Kelsey Frey awl was used to pass a wire around the arch via an extra oral approach. The wire was then twisted around part of an oral airway. Iodoform gauze was placed between the airway and skin to prevent necrosis and it was removed after 10-14 days.

**Fain J. et al (1981)**[30] described the use of a mini plates at the fronto zygomatic suture via an eyebrow incision and a sinus balloon to permit the repositioning of the cheek bone and the alignment of other fracture sites. They also stated that other fracture sites consolidate and remodel themselves spontaneously.

**James Brown et al (1983)**[32] suggested that trans nasal Krischner's wire offers stable and effective fixation of the fractured zygomatic complex with minimal morbidity. It can be combined with fronto zygomatic wiring, but has limited value in comminuted fractures of zygoma.

**Finlay P.M. (1984)**[21] compared treatment of unstable fractures using antral packs and external pins. They stated that antral packs leads to complication like infra orbital paresthesia and the cause probably was the excess amount of pigmentum iodoform in the pack.

**Michael S. Block et al (1984)**[53] described the indications for alloplastic augmentation and the surgical use of proplast for correction of malar deformity resulting from trauma and discussed the radiographic and clinical evaluation.

**Monasterio F et al (1985)**[50] described a technique to modify eyelid slanting and correct excessive scleral show. The anatomic relations of the canthal ligament with the fibrous supporting structures of the eyelid were discussed. They concluded that the procedure was indicated in aesthetic surgery, in congenital anomalies, and in sequelae of trauma.

**Butow K.W. and Eggert (1985)**[6] stated that a single four hole mini plate at fronto zygomatic suture was sufficient to stabilize the quadrilateral fracture and wire osteosynthesis in case of depressed fracture of inferior orbital margins.

**G.M. Jones (1986)**[24] described circumferential wires tied over the short length of anesthetic tubing on the face for the fixation of unstable zygomatic arch.

**Ian T. Jackson et al (1986)**[29] stated that mini plate osteosynthesis need not be routinely substituted for wire fixation, but they may be used for complex, comminuted fractures.

**Orhan Guven (1987)**[59] used an acrylic replica of the uninjured zygomatic arch on the other side to stabilize the delayed zygomatic arch fracture.

**David W. Eisele (1987)**[13] suggested the use of a single new mini-dynamic compression plate system designed specifically for zygomatic fractures which permits single point stabilization. Unstable zygomatic fracture often required stabilization at two points.

**Lowinger et al (1987)**[46] reported the occurrence of Bradycardia during elevation of zygomatic complex fractures.

**Mizuno A. et al (1987)**[56] stated that the preauricular skin incision elongated to the haired temporal region improved visibility and safety to the malar arch during surgery.

**Paul N. Manson (1987)**[62] suggested that aesthetically, the preferred areas for eyelid incisions were, first, the lower lid subciliary location; second, the upper eyelid supratarsal area; and third, in the lower eyelid over the medial portion of the inferior orbital rim. He also proved that the infra and lateral orbital rims can be explored using a single lower eyelid incision with lateral canthus mobilization. It may be either a subciliary incision or a transconjuctival incision. This approach reduced cutaneous scarring and provided generous exposure of the lower and lateral orbit.

**Ogden G.R. et al (1988)**[26] stated that clinical judgment alone is sufficient for post-operative evaluation in the management of simple fracture at the Zygomatic complex to avoid unnecessary exposure to x-radiation.

**K.De Man (1988)**[42] advocated the influence of the method of treatment of zygoma fractures on the recovery of the infra orbital nerve, and concluded that 50% suffered persistent reduced sensitivity in the infra orbital region-when FZ was fixed with wire, while only 22.1% suffered the same when FZ was fixed with mini plate osteosynthesis.

**Kunio Ikemura et al (1988)**[44] stated that there is no displacement of zygoma after fixation at fronto zygomatic region using a mini plate and additional wiring at the infra orbital rim. They suggested that there is no need of 3 or 4 point fixation except in complex comminuted fractures.

**Keith D.Holmes (1989)**[43] ensured that by combining the three – point alignment and reduction technique with rigid mini plate fixation at FZ suture, the surgeon is assured that accurate anatomic reduction, alignment and adequate stabilization of zygoma had been achieved.

**Robert B. Stanley (1989)**[79] stated that previously followed 3 point reduction may not restore proper projection of the malar prominence following a fracture dislocation of zygoma if 2 of the 3 anterior points realignment are comminuted. In such case they suggest the reconstruction of the fourth of posterior projection, the zygomatic arch, increased the accuracy of the multidimensional reconstruction.

**Paul N. Manson (1989)**[63] in his discussion on internal fixation of malar fractures outlined the importance of 2 or 3 point fixation in case of complex and comminuted fractures of the zygomatic bone. He advised four points of exposure, with coronal and anterior incision for associated lateral displacement or extreme segmentation of arch.

**N.Ravindranathan et al (1989)**[68] described a case of traumatic blindness following a malar fracture and suggested that the disruption of optic canal was the cause of blindness.

**Schneider J.F.C (1990)**[73] described a technique for reducing zygomatic complex fractures under local anesthesia, intravenous sedation and analgesia on an outpatient basis. The technique comprised of anaesthetizing the posterior superior alveolar nerve, infra orbital nerve, the main trunk of maxillary nerve, greater palatine nerve and also the naso palatine nerve following which the zygoma was elevated using a Kilner's elevator via a buccal sulcus approach.

**Micheal F.Zide, Jeffery (1990)**[52] studied 20 adult skulls and showed that when drilling perpendicular to the bone above the ZF suture, the cranial cavity can be entered as low as 12 mm above it (average, 15 mm). He concluded that drilling holes more than 12 mm over the FZ suture with the drill placed at an acute angle to the forehead prevented cranial encroachment.

**A.Al-Qurainy (1991)**[1] related the type of injury sustained to the incidence and severity of subsequent eye movement disorder. Diplopia was most common in road traffic accidents (31%) and least common with simple falls (10%). They concluded that early surgical reconstruction of midfacial fractures with conservative management of concomitant motility disorders had resulted in a very few patients having diplopia in the long term.

**Markus Zingg (1992)**[51] classified the fractures of the zygoma and outlined the treatment based on the classification. He also gave indication for closed and open reduction, the surgical technique and modification made. He classified zygomatic complex fracture into 3 types:

Type A : Incomplete zygomatic complex fracture. This may be an isolated zygomatic arch fracture ($A_1$) lateral wall fracture ($A_2$) or an infra – orbital rim fracture ($A_3$)

Type B : Complete mono fragment zygoma fracture (Tetrapod Fracture)

Type C : Multi fragment zygoma fracture, same as Type B with fragmentation including body of the zygoma.

The criteria for the surgical intervention in zygomatic complex fractures were:

1. Radiographic evidence of displacement
2. A palpable step or deformity in the orbital rim or zygomatic arch
3. Enophthalmos and extra-ocular dysfunction.

He generally agreed that not all forms of zygoma fracture need surgical intervention.

**Parent AD et al (1993)**[61] did an anatomical study on the lateral canthal tendon with specific surgical considerations. They concluded that detachment of the lateral canthal tendon may result in blunting of the lateral canthal angle, a distraction of the eyelid away from the globe, or an asymmetric repositioning of the canthus as compared with the contralateral angle. He concluded that if the periosteum of the orbit was carefully dissected from the orbital rim and re approximated following the procedure, the lateral canthal tendon insertion and function will not be disturbed unless the bony orbital margins were altered.

**E.Anastassov et al (1996)**[19] studied the precise anatomical location of the lateral canthal ligament. The ligament was a 3 mm-wide, two-tailed band; its average length approximately 13 mm, while the width of the rima palpebralis was about 26 mm. The authors evaluated three different groups to pinpoint the anatomical position of the ligament's attachment to the lateral orbital wall, and to establish guidelines for placement of the ligament during surgery. In 90% of the cases, the ligament was attached to Whitnall's tubercle, which was located approximately 4 mm posterior to the lateral orbital rim, and 17 mm above the intersection of the lateral and inferior margins and this area was 9 mm below the zygomatico frontal suture.

**Edward Eillis et al (1996)**[18] evaluated the adequacy of reduction and stability of fixation of isolated zygomatico maxillary complex (ZMC) fractures treated by various methods over a 5-year period. Based on the results, recommendations for treatment were proposed, which stated that first, all ZMC fractures do not have to be treated in the same manner, and some require less surgical intervention than the others. Second, ZMC fractures can be categorized by CT scans into those that require aggressive exposure and fixation and those that do not. Third, because the infra orbital rim is comminuted in 60% of cases it provides a poor site for stabilization, if the internal orbit does not require reconstruction, exposure of the infra orbital rim can be avoided. Alignment of the infra orbital rim can be assessed through the maxillary vestibular approach. Fourth, the amount of fixation required for

ZMC fractures can be determined at the time of surgery. Fifth, reduction can be assessed with less than four-point exposure and the ability to do so was based on several factors including the amount of edema and the experience of the surgeon.

**L.C.Manganello - Souza et al (1997)**[49] presented the transconjuctival approach to zygomatic and orbital floor fractures. It allows simultaneous exposure of inferior and lateral orbital rims and the anterior portion of zygomatic arch can be visualized, if lateral canthotomy was used and complication rate was of 12.5%.

**Greg Chotkowski et al (1997)**[25] described a technique of using a Lag screw for fixation of the fronto-zygomatic region. The advantages of the method are low profile of rigid fixation device, compression of fracture segments, added stability, and ease of placement and reduced surgical time.

**Yong Oock (1998)**[79] studied the effectiveness of the treatment of non-comminuted mono fragmented zygoma fractures using transcutaneous threaded pins and an external fixation device as closed reduction instead of open reduction and internal rigid fixation. This method has advantages over the conventional closed methods.

**Nicholas Zachariades et al (1998)**[57] analyzed the efficacy of current methods for the treatment of fracture of the ZMC and concluded that semi rigid fixation with mini plates offered most reliable methods available.

**G.Enislidis et al (1998)**[20] advocated the use of new biodegradable co-polymer osteosynthesis system for fixation of zygoma fracture. The bone healing was uneventful. The advantages were the malleability of the material when heated and avoidance of a second operation for implant removal.

**J. P.M. Vriens et al (1998)**[38] studied sensory disturbances following Orbito – zygomatic complex fracture. They concluded that the degree of sensory disturbance was method dependent. They suggest that afferent fibers of both large and small diameter tend to be permanently damaged in the patient group with closed reduction and recommended fixation of FZ suture with mini plate osteosynthesis.

**D.J. Courtney (1999)**[14] stated that treatment of ZMC through upper buccal sulcus approach and fixation with mini-plate and found the method to be safe, rapid and effective technique.

**P. Hollows et al (1999)**[64] described a rare case of life threatening hemorrhage after elevation of a fractured zygoma as a result of retro bulbar hemorrhage. This case illustrated the need for routine eye observations post – operatively. Similarly **N.Pigadas** in 2005, registered as case of intra orbital hematoma from anterior ethmoidal artery after ZMC reduction.

**J.G.Mc. Gimpsey et al (2000)**[34] evaluated the role of thermography in the assessment of infra orbital nerve injury after malar fractures and concluded that it had little place in the assessment.

**M. Krimmel et al (2002)**[55] used the endoscope for zygomatic fracture reduction and osteosynthesis through an upper buccal sulcus and preauricular approach. Their use was advocated in severely comminuted zygoma fracture as the malar arch was a key landmark for restoration of facial width. Scarring was minimal, frontal branch of facial nerve intact. Only disadvantage being the operative time increased as the technique was difficult.

**M. Heiland et al (2005)**[54] demonstrated the intra – operative cone beam computed tomography (CBCT) using the SIREMOBILE ISO – C 3D was suitable for assessment of post – operative results following ZMC reduction.

**Lisa A. Crighton et al (2006)**[47] studied the need for post – operative radiographs in the management of zygomatic fractures through a prospective study and concluded that clinical evidence was lacking to support the need for routine post – operative radiographs for ZMC fracture management.

**Paik – Kwon lee, et al (2006)**[60] performed a single transconjuctival incision with lateral canthal extension in 53 patients with non-comminuted zygomatic complex fractures and proved that the method had the advantage that it left only an inconspicuous lateral canthal scar and in addition it provided excellent simultaneous visualization of the inferior orbital rim and frontozygomatic suture area with a lower incidence of complications, including visible scarring and ectropion.

**Conor P. Barry et al (2007)**[8] did a cadaveric study to delineate the attachments of temporalis muscle and the ability of this muscle contraction to cause post-operative collapse after reduction of ZMC. He concluded that functional forces exerted by this muscle on the ZMC cause post – operative distraction of the fronto zygomatic suture. This provided evidence to support internal fixation of all fractures of the ZMC even those that were considered clinically stable.

**Eski. M. Sengerzer et al (2007)**[17] stated that inappropriate treatment or untreated fractures of the zygomatico orbital area resulted in secondary deformities such as loss of malar projection, enophthalmos and dystonia. Secondary deformities can be corrected with osteotomies, contour restoration, or a combination of both. In the study, he used a porous polyethylene implant, which was a highly biocompatible, durable, and stable material and concluded that best result can be achieved with this implant in contour restoration of mild to moderate secondary deformities of zygomatico-orbital fractures. The use of this implant in the zygomatico-orbital area was safe and had minimal morbidity.

**Tang J et al (2008)**[36] explored the secondary surgical reconstruction for orbital bone deformities accompanied with canthus dislocation after trauma. According to the fractured position and the degree of deformity and dislocation, the orbito-zygomatic fracture was repositioned after osteotomy and rigid fixation, or the healed fragments were trimmed with a bur and the depressed fragments were filled with autogenous bone such as ilium, cranial outer table or Medpor in order to reconstruct orbital wall framework; the orbital walls were repaired to correct the enophthalmos with autogenous bone or Medpor after the herniated orbital contents were released. They concluded that surgical reduction combined with bone grafting was a satisfactory method for the correction of secondary orbital bone deformity and the repair of canthus dislocation and correction of enophthalmos should be considered at the same time.

**Conor Barry (2008)**[9] evaluated the incidence of ocular injuries and clinical ocular signs and they concluded that these injuries occur more often in patients with orbital blowout fractures compared with comminuted orbito-zygomatic complex fractures or simple orbito-zygomatic complex fractures. Ophthalmology consultation was recommended for all patients presenting with orbito-zygomatic fractures, and was essential for patients with orbital blowout fractures, based on the high incidence of clinical ocular findings and injuries in this subgroup of patients.

**L. Xie, Y. Shao (2009)**[48] introduced an endoscopic-assisted approach via a small preauricular incision to achieve reposition and osteosynthesis of isolated zygomatic arch fractures. They concluded that the endoscope-assisted approach via a small preauricular incision can achieve in situ reduction and fixation in zygomatic arch fracture and it should become an integral part of isolated zygomatic fracture repair.

**Hongbo Yu (2010)**[27] evaluated the effectiveness of image-guided navigation on open reduction and orbital floor reconstruction as treatment for zygomatic-orbital-maxillary complex fractures. They concluded that Navigation-guided open reduction of zygomatic-orbital maxillary complex fractures with orbital floor reconstruction could be regarded as a valuable treatment option for this potentially complicated procedure.

**Olate. S (2011)**[76] conducted a 10 year study in 532 patients to establish conditions for surgical and non-surgical treatment of zygomatic complex (ZC) fractures and concluded that variables as comminuted fracture and alteration of occlusion were associated to surgical treatment indications; In cases of displacement bigger than 5 mm, approaches to 3 of 4 points of the ZC were mandatory to reduce the fractures. The infraorbital rim and zygomaticofrontal suture approaches were indicated to treat displaced fractures.

**Jian-ping Li (2011)**[35] developed a feasible intraoperative guiding device using computer-aided design and computer-aided manufacturing of individual templates to permit anatomic fracture reduction of zygomatic-orbitomaxillary complex (ZOMC) comminuted fractures. He concluded that the technique was a simple, economical and readily accessible method of comminuted ZOMC fracture reduction that can be learned and used rapidly.

**Seon Tae Kim (2011)**[74] compared 1-point fixation in the zygomaticomaxillary (ZM) area with 2-point fixation in the ZM and frontozygomatic (FZ) areas in tripod fractures and concluded that one-point fixation in the ZM area in zygomatic tripod fractures avoided unsightly scars and gave high satisfaction with surgical outcomes in selected patients with tripod fractures.

**B. A. Stuck (2012)**[4] demonstrated the potential benefits of a new mobile CBCT system in a series of patients with complex facial fractures. Intraoperative CBCT was successfully performed in all patients and has led to immediate consequences in 12 (26%) cases. In 5 cases, fracture reduction turned out to be insufficient and was further optimized and in 5 other cases the titanium implant (orbital mesh) was not placed in the optimal position and the position was corrected. Bony fragments were detected and removed in 2 cases. They concluded that intraoperative imaging provided a number of advantages over post-therapeutic imaging in the management of facial fractures.

**Daniel Augusto Gaziri (2012)**[11] evaluated a new rigid internal fixation device called a “neck screw” which was applied to patients presenting with a tripod fracture of the zygomatico-maxillary complex. The fixation stability provided by the neck screw was confirmed by subsequent CT scan measurements, statistical analysis and clinical follow-up during the postoperative period, in which patients showed no significant associated complications, facial asymmetry, enophthalmos, or diplopia.

**Dongmei He (2012)**[15] compared the results of traditional surgery, navigation-guided surgery and 3-dimensional (3D) model–guided surgery. They concluded that computer-assisted surgery improved the treatment results of delayed orbitozygomatic fracture with enophthalmos. Navigation-guided surgery with a 3D model and titanium mesh with Medpor were the best ways to treat delayed orbitozygomatic fractures with severe enophthalmos.

# MATERIALS AND METHODS

A retrospective study that included 22 patients with Unilateral fractures of Zygomatico-maxillary complex treated by Direct and Indirect reduction methods with or without internal fixation using trans osseous wires or mini plates and screws in the Department of Oral and Maxillofacial Surgery, Sri Ramakrishna Dental College and Hospital from the year December 2010 to June 2012.

Of the 22 cases, all were male patients. All cases were treated immediately after obtaining neuroclearance within a period of one week. 19 patients were as a result of road traffic accidents, 2 cases of assault and 1 case of work injury. 15 cases sustained fractures over the right zygoma while the other 7 cases sustained fractures of the left zygoma. 3 cases were isolated right zygomatic arch fractures.

Age, sex, cause of injury, side of injury, diagnosis and associated facial fractures were recorded from the case files.

## EXCLUSION CRITERIA:

The patients are excluded:

1. When there was a fracture of the contralateral zygomatic complex or an associated Lefort fracture.
2. When the patient was neurologically unstable.

3. When follow up post-operative radiographs of less than 5 weeks were not done or available.

A thorough pre-operative clinical examination supplemented with photographs, Computed tomography and/or Para nasal sinus views and Submentovertex view radiographs were done for all the cases. The details of the pre-operative examination were recorded in a standard case report proforma. After confirming the diagnosis of a unilateral fracture zygoma, the case was taken up for surgery with the patient's consent. All cases were operated under general anesthesia. Immediate post-operative PNS & SMV radiographs (within 36 hours) were taken to assess the adequacy of reduction. The patients were followed up and PNS & SMV radiographs were taken at the 5$^{th}$ post-operative week to assess the adequacy of fixation. At this time the facial photographs were also taken. The data collected were segregated in the following tables:

1. Distribution of patients among age group.
2. Distribution of patients according to cause of injury.
3. Distribution of Zygomatic-complex fracture sites.
4. Presence of associated fractures.
5. Classification of Zygomatic fractures and its treatment modality.
6. Pre-operative evaluation.
7. Post-operative evaluation.
8. Adequacy of reduction.

9. Adequacy of fixation.
10. Inadequate reduction.
11. Inadequate fixation.
12. Results.

**METHOD OF STUDY:**

A thorough systemic examination was done for all the cases to rule out injuries to other organs. After these injuries were ruled out, a thorough clinical and radiographic assessment was made for fracture of zygomatico maxillary complex. This consisted of good quality photographs, Computed Tomography and/or Para nasal sinus view and a Submentovertex view. The details of injury were recorded in a standard proforma. The cases were randomly taken into treatment by various modalities of direct and indirect reduction. The pre-operative findings like facial asymmetry, infra orbital nerve paresthesia, mouth opening and associated complications were recorded. The findings were tabulated.

After the surgical procedure once the patient was fit to be mobilized, post-operative radiographs (PNS, SMV) were taken within 36 hours to check the adequacy of reduction. The patients were given routine antibiotics and analgesics both pre and post operatively.

5$^{th}$ week after the surgical procedure was fixed for postoperative follow up for all the patients. During follow up, routine radiographs (PNS and SMV) were taken to check for the adequacy of fixation. Photographs were also taken to assess the facial asymmetry.

The following parameters were used to assess the quality of reduction and stability offered by the various treatment modalities studied and the details were recorded and tabulated.

1. Mouth opening.
2. Infra orbital paresthesia.
3. Facial symmetry.
4. Adequacy of reduction.
5. Adequacy of fixation/ stability.
6. Complications associated.

**Mouth opening:**

The amount of mouth opening was measured pre operatively and post operatively and recorded in millimeters.

**Infra orbital nerve paresthesia:**

The patients perception of infra orbital paresthesia was recorded pre operatively and post operatively and recorded as Present/ Absent.

**Facial symmetry:**

This was assessed from good quality facial photographs [frontal, lateral (Right & Left), Bird's eye view] taken at $5^{th}$ post-operative week. The malar symmetry, position of globe and eyelids, facial width and scars were assessed by the operative surgeon himself. The findings were recorded.

**Adequacy of reduction:**

Adequacy of reduction was determined by assessing the post-operative images taken within 36 hours of surgery. It was realized that the plain radiographs were somewhat magnified. No magnification correction was used for plain films because the correction factor was not known. It is difficult to obtain a film using a standardized subject – film distance during acquisition in such trauma patients. However, most comparisons were made with the opposite side and tabulated in millimeters of difference. Measurements were made on acetate tracing paper. Any asymmetry on the images less than 2mm in magnitude was considered acceptable reduction of the fracture. It has been shown that a clinician can detect a 2mm difference in facial form only 50 % of the time. Asymmetries more than 2mm were tabulated.

The Para nasal sinus and Submentovertex radiographs were used for analysis.

**PARANASAL SINUS VIEW:**

The following parameters were assessed, using the opposite side for comparison:

1. Orbital size
2. Contour of the Zygomatico-maxillary buttress
3. Alignment of infra-orbital rim
4. Approximation of fronto-zygomatic suture.

**Orbital size:**

The widths of the orbits were measured in millimeters, from the anatomical landmarks such as:

1. LO – Intersection of greater wing of sphenoid to the lateral orbital rim.
2. LE – Intersection of ethmoid bone to the lacrimal crest.

The difference between them was scored.

**Alignment of infra-orbital rim:**

Alignment of the medial and lateral portions of the infra-orbital rim was measured with a millimeter ruler when not continuous with the medial portion. If there was a discontinuity, the lateral portion of the rim was scored as being a certain distance above or below the medial portion.

**Contour of the Zygomaticomaxillary buttress:**

The contour was assessed by the amount of displacement the zygomaticomaxillary complex showed in relation to the alveolar process.

**Separation of the fronto-zygomatic suture:**

It was measured in millimeters with a caliper and ruler.

**SUBMENTOVERTEX VIEW:**

The following parameters were assessed:

1. Projection of the malar buttress.
2. Contour of the zygomatic arch.

**Projection of the malar buttress:**

The vertical portion of a custom made clear T- slab was aligned along the midline structures within the cranium and the horizontal limb of the T was aligned with the uninjured malar prominence. The distance between the operated malar prominence and the other limb of the T was measured with direction (anterior or posterior).

**Contour of the Zygomatic arch:**

It is assessed in relation to the opposite, uninjured side. The injured zygomatic arch was classified as aligned, bowed laterally, or displaced posteriorly. No quantitative measurement was taken.

**Analysis of data:** A difference of more than 2mm between the treated and non-fractured side was considered significant and tabulated as inadequate reduction / fixation.

**Adequacy of fixation:**

To determine whether there was any post-operative displacement of ZMC, immediate post-operative radiographic images were compared with those obtained 5 weeks after surgery. Any difference between the two was measured as described above for adequacy of fixation.

**Complications associated:**

The complications of the procedure were obvious from facial photographs and clinical observations were recorded. Malar symmetry, position of the globe (enophthalmos, pupillary height), eyelid position and form, facial width and obvious scars were qualitatively assessed. If devoid of these changes the case was considered satisfactory. Based on the results a consensus was reached as to which treatment modality was most appropriate.

All cases were reduced by Keen’s / Upper buccal sulcus approach. The approach is described in detail.

**KEEN’S / UPPER BUCCAL SULCUS APPROACH**

Keen in 1909, described an intra-oral approach for zygomatic complex fracture reduction. A small incision approximately 1cm is made in the mucobuccal fold, just beneath the zygomatic buttress of the maxilla. The incision can be made from anterior to posterior or from medial to lateral and should extend through the mucosa, submucosa and buccinators muscle fibres. The sharp end of number 9 periosteal elevator is inserted into the incision and using a side to side sweeping motion, the surgeon makes contact with the infra temporal surface of the maxilla, zygoma and zygomatic arch and dissects the tissue in a supra periosteal manner. A heavier instrument such as Rowe's zygomatic elevator can then be inserted behind the infra temporal surface of the zygoma. Using superior, lateral and anterior force, the surgeon reduces the bone. A hand placed over the side of the face to assist in the reduction is extremely helpful. One should take care to avoid using anterior maxilla as point of fulcrum. The incision in the mucobuccal fold is sutured with silk or cat gut suture material.

**Fig.1: ARMAMENTARIUM**

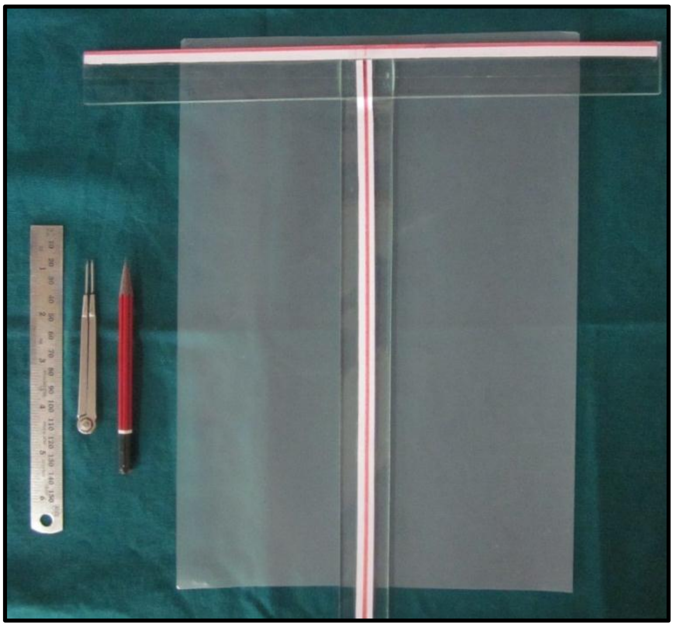


**Fig.2: CUSTOM MADE T-SCALE**

**PLAIN RADIOGRAPHS USED**

**Fig.3: PARANASAL SINUS VIEW**


**Fig.4: SUBMENTO VERTEX VIEW**

## RADIOGRAPHIC ASSESSMENT WATER'S VIEW

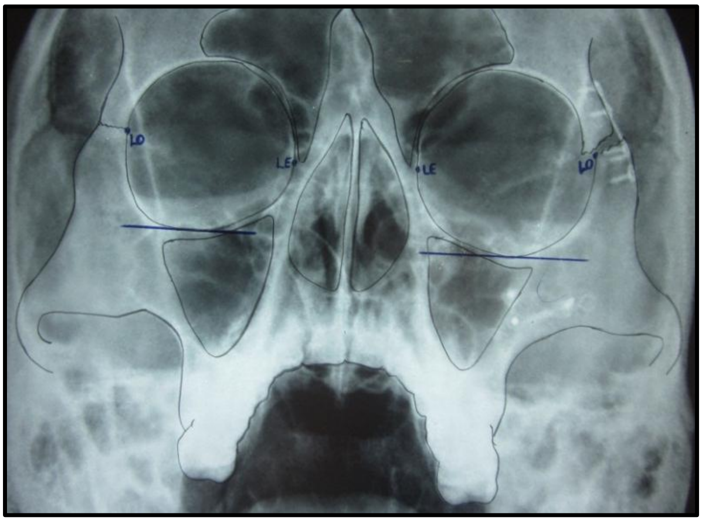


**Fig.5: ORBITAL SIZE AND ALIGNMENT OF INFRA ORBITAL RIM**

## SUBMENTO VERTEX VIEW

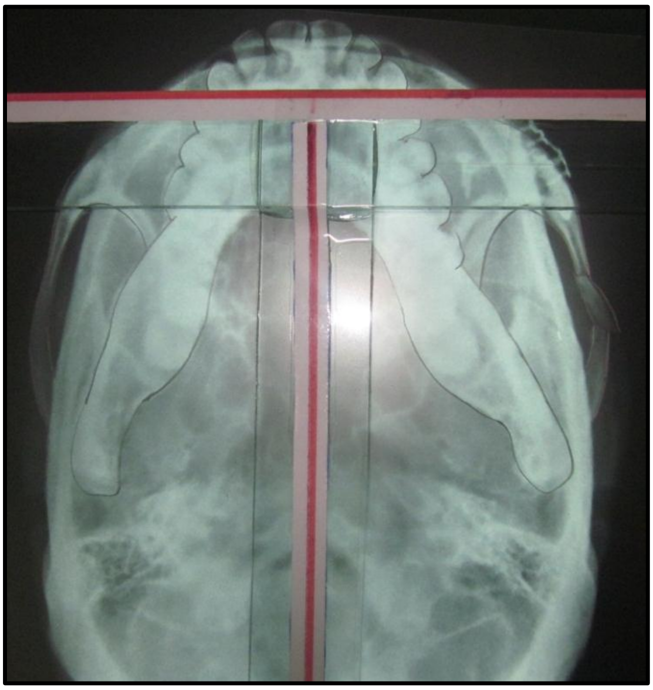


**FIG.6: PROJECTION OF MALAR BUTTRESS AND CONTOUR OF ZYGOMATIC ARCH**

## CASE REPORT PROFORMA

## DEPARTMENT OF ORAL AND MAXILLOFACIAL SURGERY
## SRI RAMAKRISHNA DENTAL COLLEGE & HOSPITAL, COIMBATORE

Name : Age: Sex:

Address :

Occupation :

I.P.No :

Date & time of Entry: Other consultants involved:

**Cause:** **Location:**

**Taken to:** **Diagnosis:**

**Treatment given:**

**Condition on admission:**

Stretcher / chair / ambulant

Vomited : Yes / No

Shock : Absent / Mild / Severe

Airway : Clear / Obstruction

Alcohol : Yes / No

**BP:** **Pulse:** **Temp.:** **Resp.:**

**Complaints:**

- Facial Asymmetry / Malar Depression.
- Inability to Open the Mouth.
- Abnormal Sensation Over the Infra Orbital Region.
- Abnormal Vision /Disturbed Vision.
- Bleeding Through the Nose.
- Inability to Masticate.

**LEVEL OF CONSCIOUSNESS:**

Fully oriented

Responds to simple commands

Correctly localizes painful stimuli

Responds to pain – cannot localize stimulus

No response

**GCS Score:**

**HISTORY**

**Cause of Trauma**

**a)** R.T.A

**b)** Fall

**c)** Assaults

**d)** Industrial

**e)** Others

- H/O Unconsciousness
- H/O Vomiting
- H/O Amnesia
- H/O Epistaxis
- H/O Bleeding From Mouth
- Number Of Days Elapsed After Trauma.

**Medical History**

**Personal History**

**Family History**

**General Examination:**

## MAXILLOFACIAL INJURIES:

### Cranial Nerve Examination:

| | RIGHT | LEFT |
|---|---|---|
| I | | |
| II | | |
| III | | |
| IV | | |
| V | | |
| VI | | |
| VII | | |
| VIII | | |
| IX | | |
| X | | |
| XI | | |
| XII | | |

## OCCULAR EXAMINATION:

a) Enophthalmos : Present / absent

b) Ptosis : Present / absent

c) Orbital Dystopia : Present / absent

d) Diplopia : Present / absent

e) Blurring of vision : Present / absent

f) Subconjuctival Hemorrhage : Present / absent

| Eye movements | | Right | Left |
|---|---|---|---|
| Upwards: | Outwards | | |
| | Inwards | | |
| Downwards: | | | |
| | Outwards | | |
| | Inwards | | |

| Pupillary reflex | Right | Left |
| --- | --- | --- |
| Pupil size | | |
| Light | | |
| Accommodation | | |
| Corneal | | |

Muscle tone:

Coordination:

Sensory loss:

| Maxillofacial Signs | Visible |
| --- | --- |
| Hemorrhage | |
| Laceration | |
| Tissue loss | |
| Abrasion | |
| Edema | |
| Ecchymosis | |
| Contour defects | |
| CSF Leak : Nose / Ear | |

| Maxillofacial Signs | Palpable |
|---|---|
| Cranium | |
| Orbital margins | |
| Nasal bones | |
| Zygomatic complex<br>• Fronto zygomatic<br>• Infra orbital<br>• Zygomaticomaxillary buttress<br>• Zygomatic arch<br>• Body of Zygoma | |
| Condyles | |
| Mandibular border | |
| Compression test | |
| Maxilla | |
| Step deformity | |

**EXTRA ORAL EXAMINATION:**

1. **Facial Symmetry:**
   a) Position of malar prominence : Normal / Flattened/ Increased
   b) Position of the Zygomatic arch : Normal / flattened.
2. **TMJ movements:**
3. **Mouth opening (in mm):**

**INTRA ORAL EXAMINATION:**

1. **Hard tissue examination:**
   - Occlusion :
   - Missing teeth :

- Teeth to be extracted :
- Teeth recently displaced :
- Root stumps :
- Fractured teeth :
- Avulsed teeth :

2. **Soft tissue examination:**
   - Soft palate :
   - Hard palate :
   - Buccal mucosa :
   - Gingiva :
   - Floor of the mouth :
   - Tongue :

**RADIOLOGICAL EXAMINATION:**

OPG / Occlusal view

CT scan (Facial Bones)

3D CT Reconstruction View

PNS View

Submentovertex view

TMJ View

**Investigations**

**1. BLOOD**

- Complete Blood Count
- Bleeding time
- Clotting time
- Blood Group
- Blood Sugar

- Fasting
- Post Prandial

- Serum Urea
- Serum Creatinine
- H.I.V
- Hbs Ag

**2. URINE**

Routine Urine Analysis

- Microscopic
- Specific

**3. E.C.G**

**4. CHEST P.A.VIEW**

**DIAGNOSIS:**

**CLASSIFICATION OF ZYGOMATIC FRACTURES (*Markus Zingg in 1992*)**

Type A : Incomplete zygomatic complex fracture. This may be an isolated zygomatic arch fracture ($A_1$) lateral wall fracture ($A_2$) or an infra – orbital rim fracture ($A_3$).

Type B : Complete mono fragment zygoma fracture (Tetrapod Fracture).

Type C : Multi fragment zygoma fracture, same as Type B with fragmentation including body of the zygoma.

**ANY OTHER ASSOCIATED FRACTURES:**

Mandible

Maxilla

Lefort I

Lefort II

Lefort III

Cranial bones

**TREATMENT GIVEN:**

# REVIEW PROFORMA

**Postoperative evaluation – (Immediate & 5th week)**

**Patient Name:** **Age:** **Sex:**

**Address:** **Phone:**

**Diagnosis:**

**Classification (Markus Zingg):**

**Treatment done:**

## Clinical Findings

1. **Facial Symmetry:**

Position of malar prominence : Normal / Flattened/ Increased

Position of the Zygomatic arch : Normal / flattened.

2. **Infra orbital nerve paresthesia** : Present / absent

3. **Orbital complications:**

Enophthalmos : Present / absent

Ptosis : Present / absent

Orbital Dystopia : Present / absent

Diplopia : Present / absent

Blurring of vision : Present / absent

Subconjunctival Haemorrhage : Present / absent

Eye movements : Normal / restricted

Pupillary reflexes : Normal / altered

**4. Occlusal disturbances**

Dearranged Occlusion : Yes / No

Jaw movements : Centric / Deviated

Tooth devitalization : Yes / No

**Maximum interincisal opening (mm)** :

**5. Infected plates / screws** : Yes / No

If yes, site:

## Radiographic Findings:

### PARANASAL SINUS VIEW:

| | | |
|---|---|---|
| 1. | Orbital size (mm) | : Right – |
| | | : Left – |
| | | : Difference – |
| 2. | Alignment of infra orbital rim | : Continuous - |
| | | : Not continuous (in mm) - above/ below the medial portion |
| 3. | Contour of the Zygomaticomaxillary Buttress | : Aligned - |
| | | : Rotated (in mm) – medial / lateral / inferior |
| 4. | Approximation of Fronto zygomatic suture | : Yes (mm) / No |

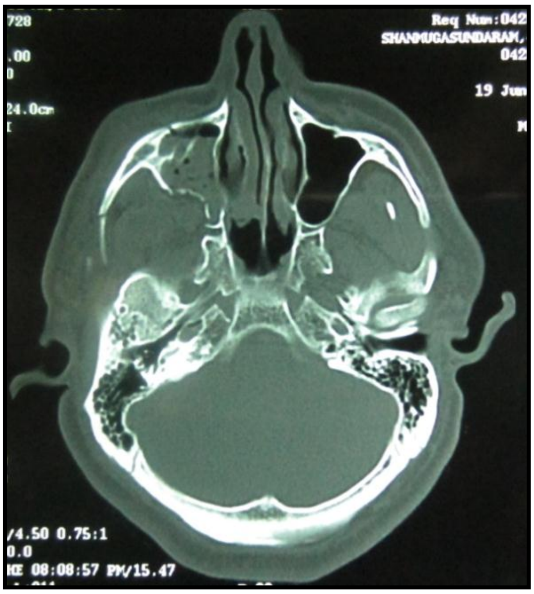
### SUBMENTO-VERTEX VIEW:

| | | |
|---|---|---|
| 1. | Projection of Malar Buttress | : Normal - |
| | | : Mal-alignment (in mm) - Anterior / Posterior to limb of the T- Scale |
| 2. | Contour of Zygomatic Arch | : Aligned / Bowed laterally / Displaced posteriorly |

# TYPE A FRACTURE - INDIRECT REDUCTION WITHOUT FIXATION

**Fig.7: PREOPERATIVE PHOTOGRAPHS**


**PARANASAL SINUS VIEW** **SUBMENTOVERTEX VIEW**




**CT SCAN**

**Fig.8: PREOPERATIVE RADIOGRAPHS AND CT SCANS**

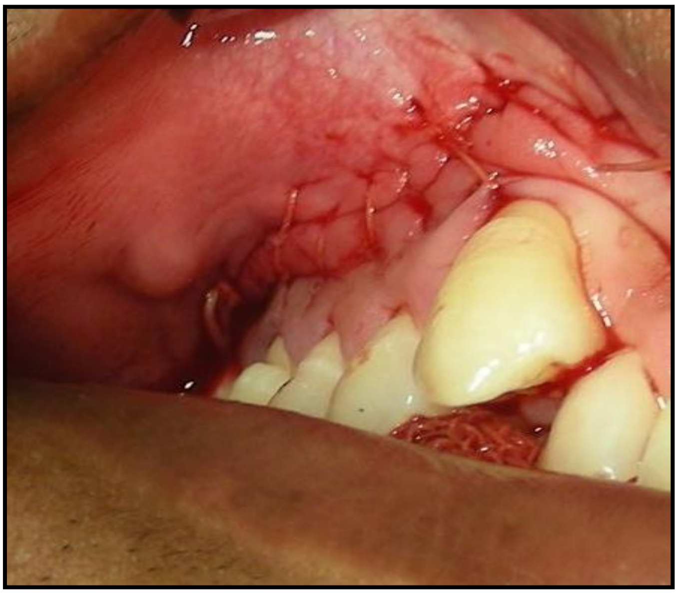


**Fig.9: INTRA OPERATIVE PHOTOGRAPHS**


**Fig.10: TRACING - IMMEDIATE POST OPERATIVE RADIOGRAPHS**


**Fig.11: TRACING 5TH WEEK POST OPERATIVE RADIOGRAPHS**

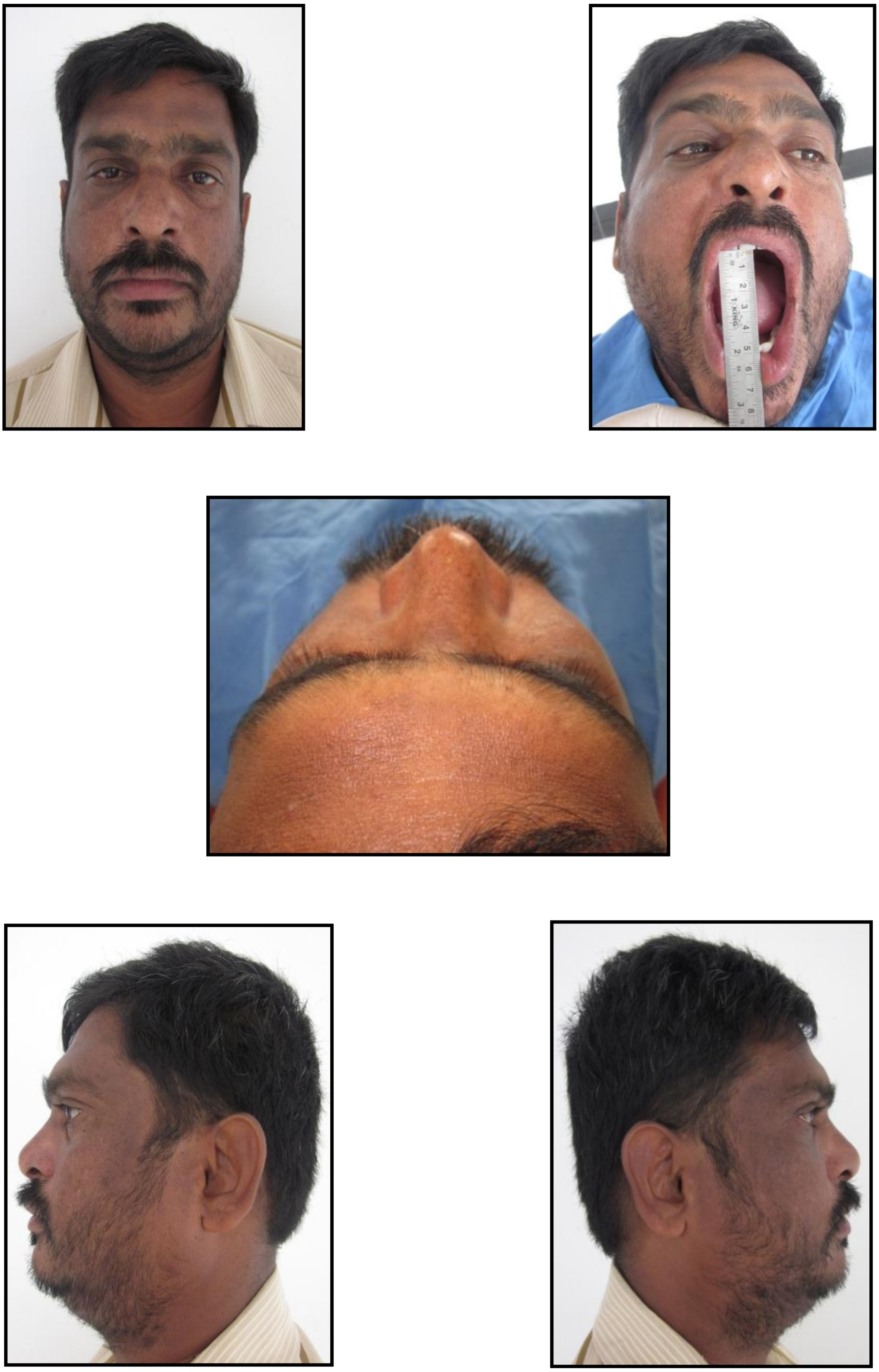


**Fig.12: POST OPERATIVE PHOTOGRAPHS**

# TYPE A FRACTURE – DIRECT REDUCTION AND ONE POINT FIXATION (ZMB) WITH MINIPLATE

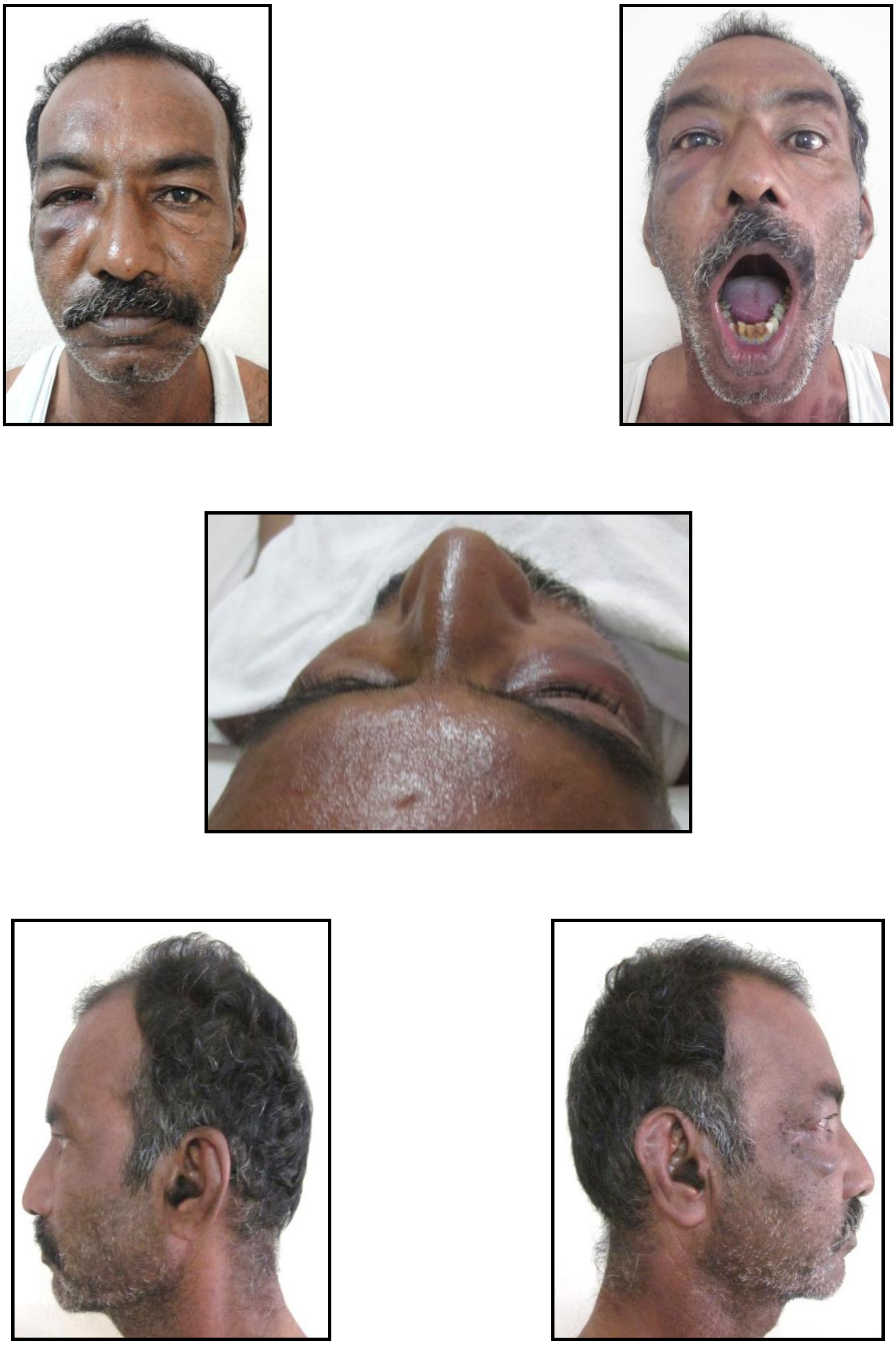
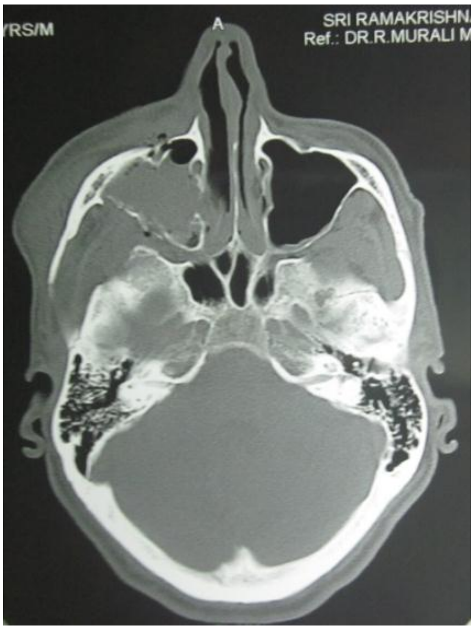


**Fig.13: PRE OPERATIVE PHOTOGRAPHS**


PARANASAL SINUS VIEW

SUBMENTO VERTEX VIEW




CT SCAN (AXIAL VIEW)

CT SCAN (3-D VIEW)

**Fig.14: PRE OPERATIVE RADIOGRAPHS AND CT SCANS**

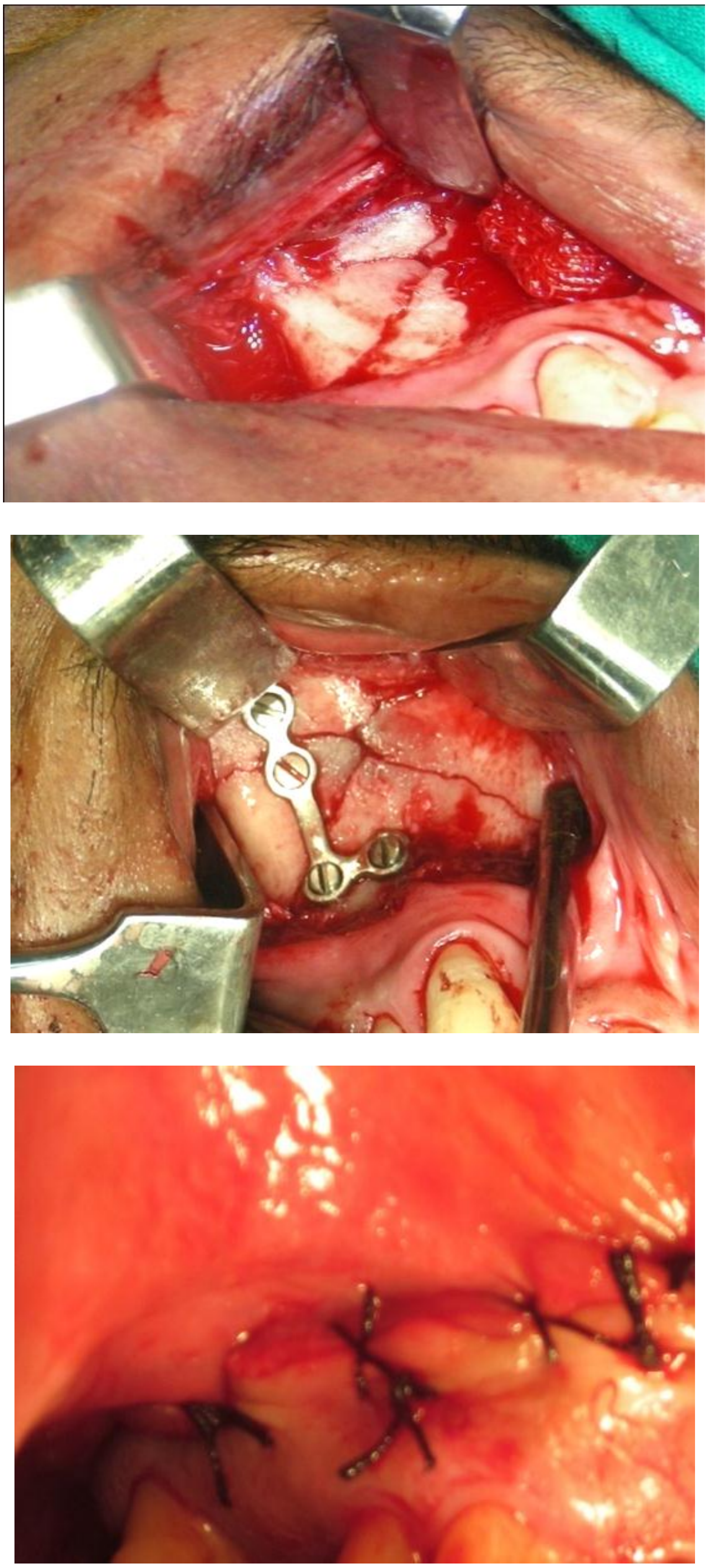


**Fig.15: INTRA OPERATIVE PHOTOGRAPHS**

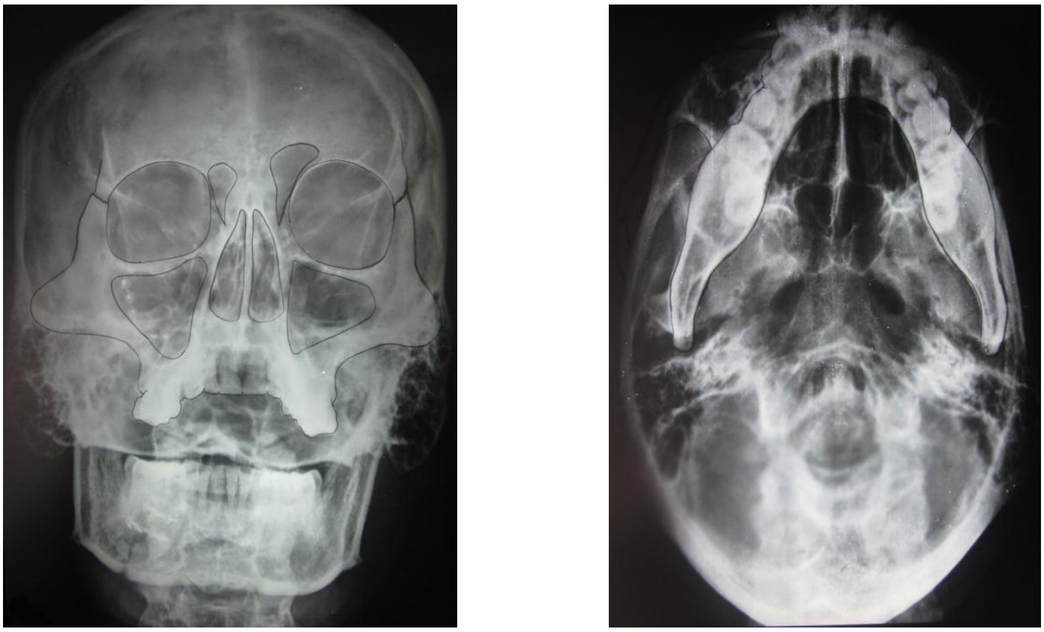


**Fig.16: TRACING - IMMEDIATE POST OPERATIVE RADIOGRAPHS**

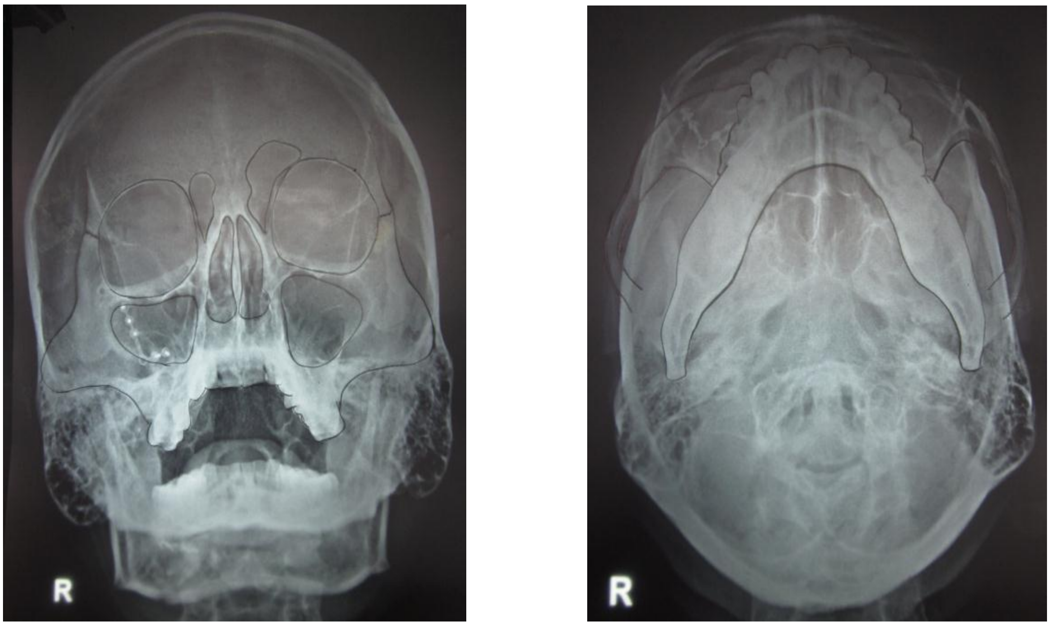


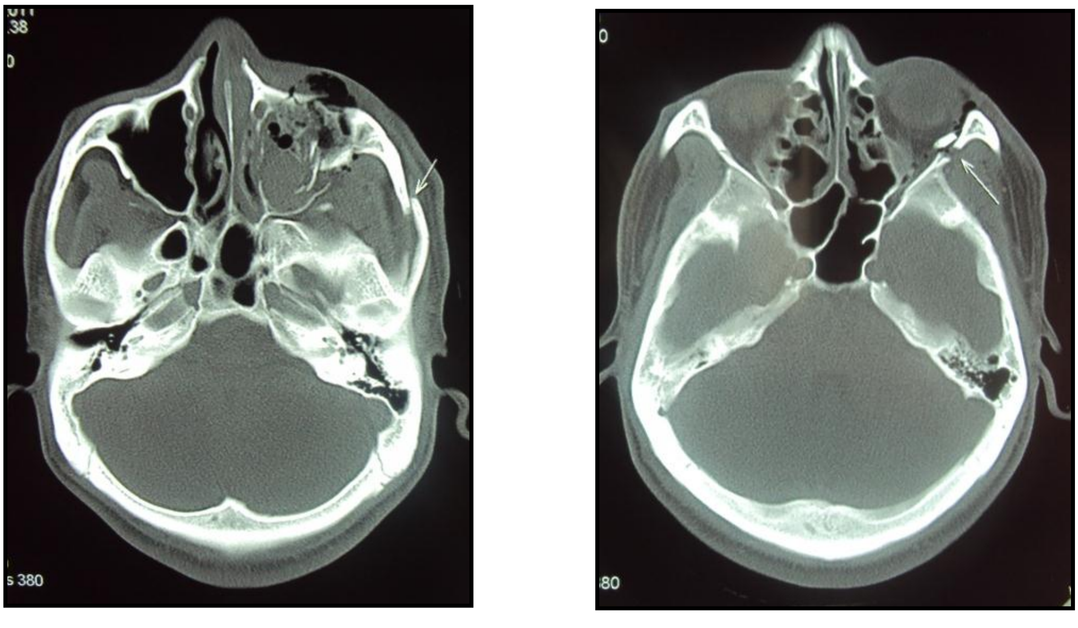

**Fig.17: TRACING - 5TH WEEK POSTOPERATIVE RADIOGRAPHS**

**Fig.18: POST OPERATIVE PHOTOGRAPHS**

# TYPE B FRACTURE – DIRECT REDUCTION AND ONE POINT FIXATION (FZ) WITH MINIPLATE

**Fig.19: PRE OPERATIVE PHOTOGRAPHS**

**PNS VIEW**



**CT SCAN (AXIAL VIEW)**

**Fig.20: PRE OPERATIVE RADIOGRAPHS AND CT SCANS**

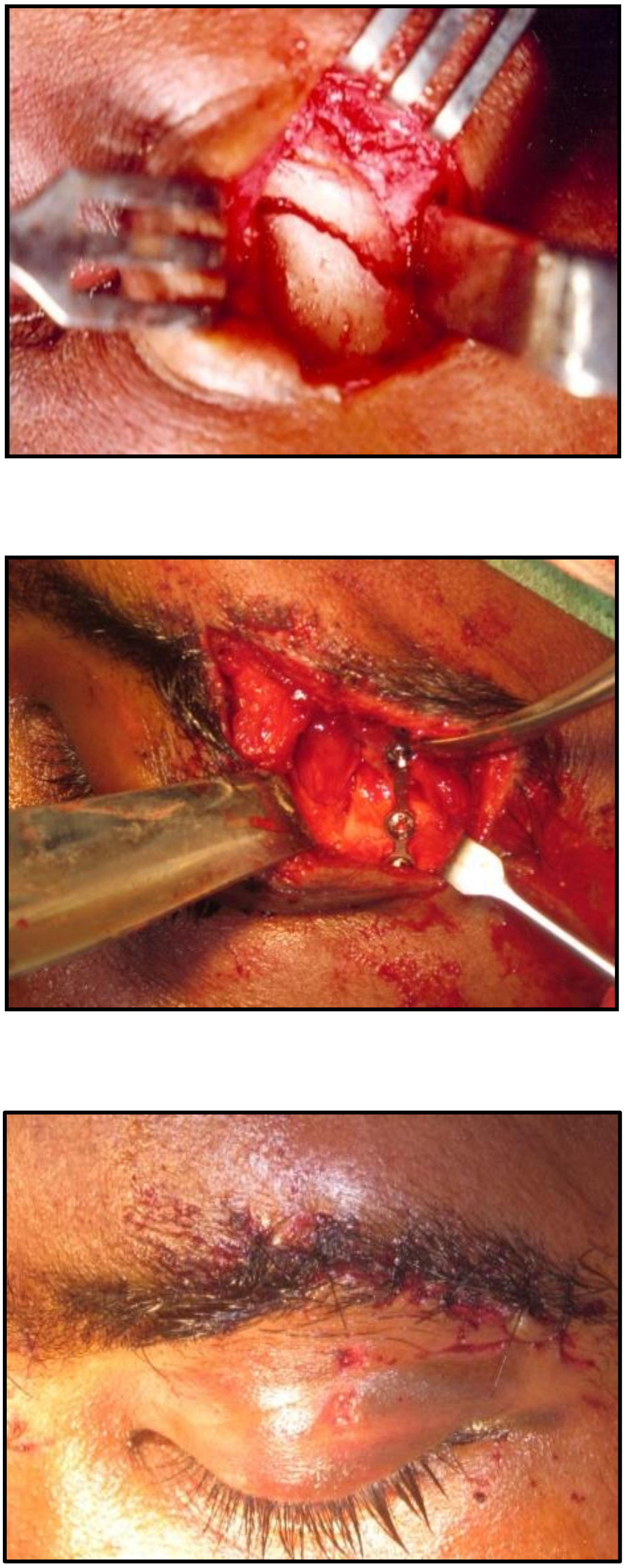


**Fig.21: INTRA OPERATIVE PHOTOGRAPHS**

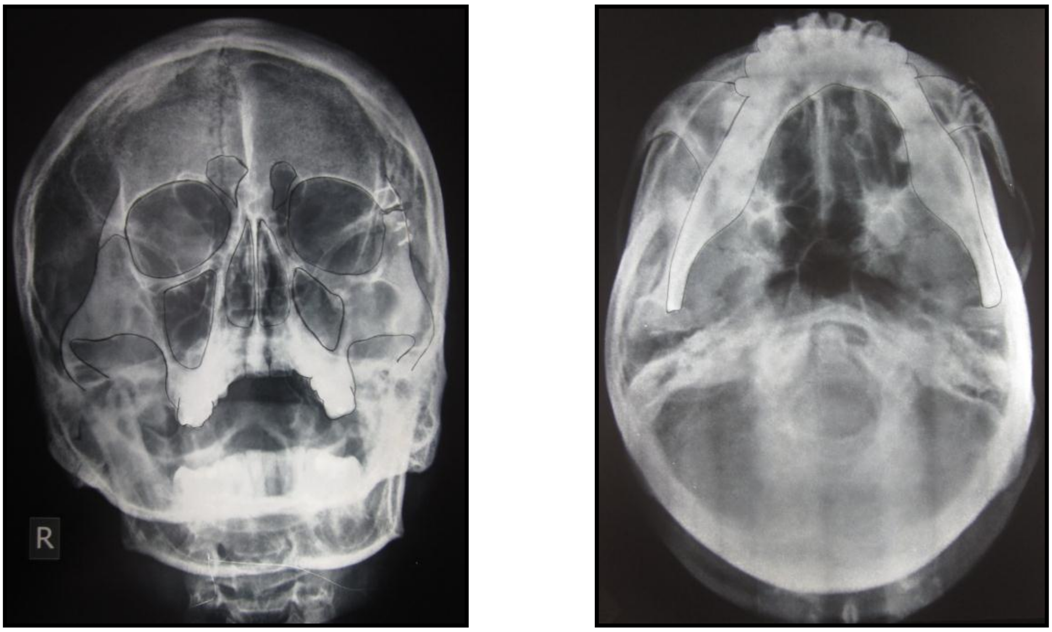


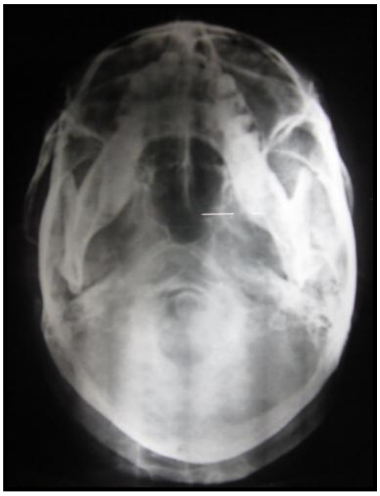

**Fig.22: TRACING – IMMEDIATE POST OPERATIVE RADIOGRAPHS**

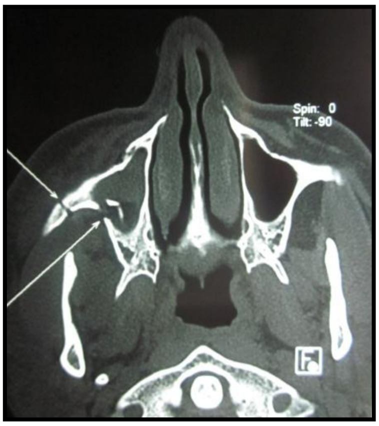

**Fig.23: TRACING – 5$^{TH}$ WEEK POST OPERATIVE RADIOGRAPHS**

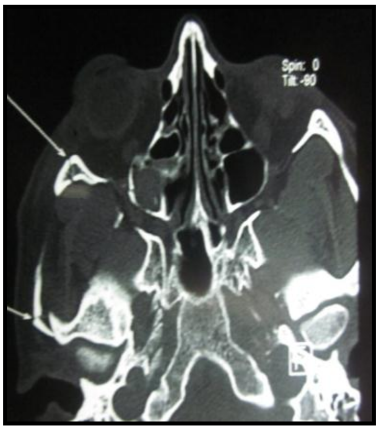
**Fig.24: POST OPERATIVE PHOTOGRAPHS**

# TYPE B FRACTURE – DIRECT REDUCTION AND TWO POINTS FIXATION (FZ + ZMB) WITH MINIPLATES

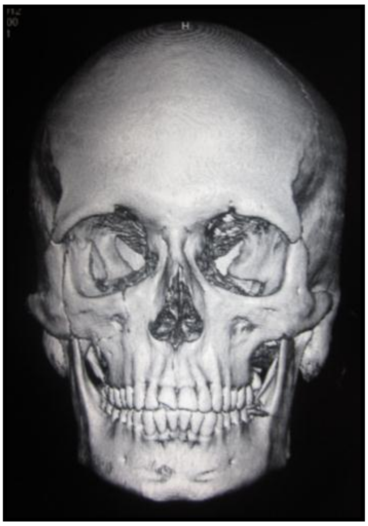
**Fig.25: PRE OPERATIVE PHOTOGRAPHS**






**CT SCAN (AXIAL VIEWS)**





**CT SCAN (3D VIEW)**

**Fig.26: PRE OPERATIVE RADIOGRAPHS AND CT SCANS**

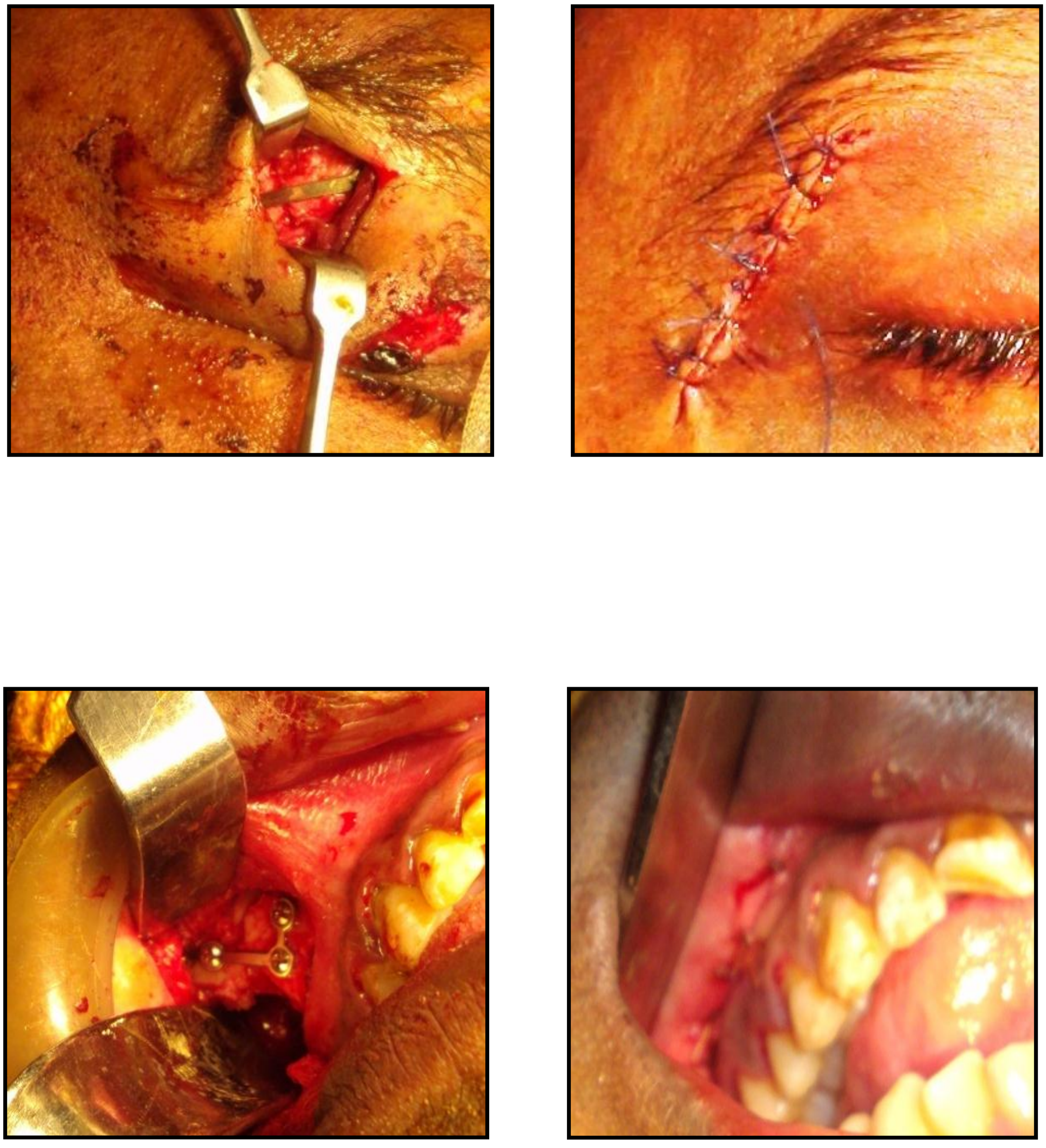


**Fig.27: INTRA OPERATIVE PHOTOGRAPHS**

**Fig.28: TRACING – IMMEDIATE POST OPERATIVE RADIOGRAPHS**

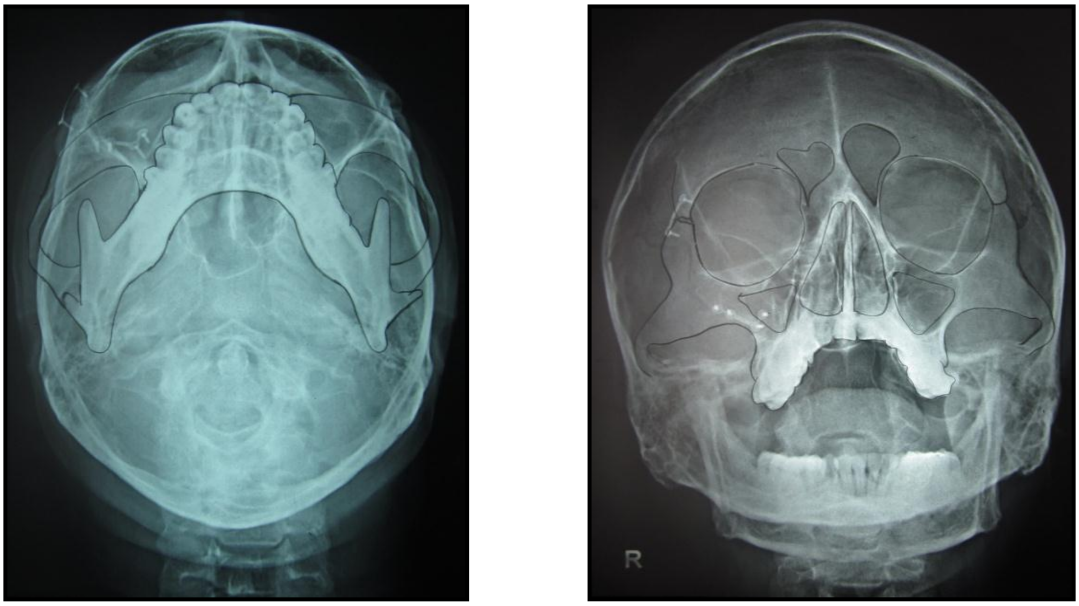



**Fig.29: TRACING – 5$^{TH}$ WEEK POST OPERATIVE RADIOGRAPHS**

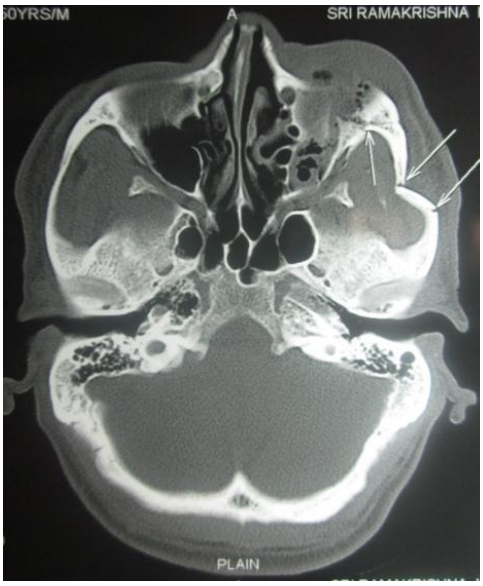
**Fig.30: POST OPERATIVE PHOTOGRAPHS**

# TYPE C FRACTURE – DIRECT REDUCTION AND TWO POINTS FIXATION (FZ + ZMB) WITH MINIPLATES

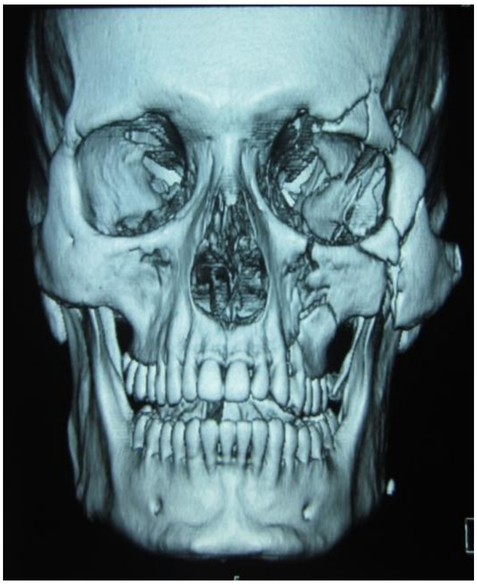
**Fig.31: PRE OPERATIVE PHOTOGRAPHS**


**PNS VIEW**

**SUBMENTOVERTEX VIEW**




**CT SCAN (AXIAL VIEW)**



**CT SCAN (3D VIEW)**

**Fig.32: PRE OPERATIVE RADIOGRAPHS AND CT SCANS**

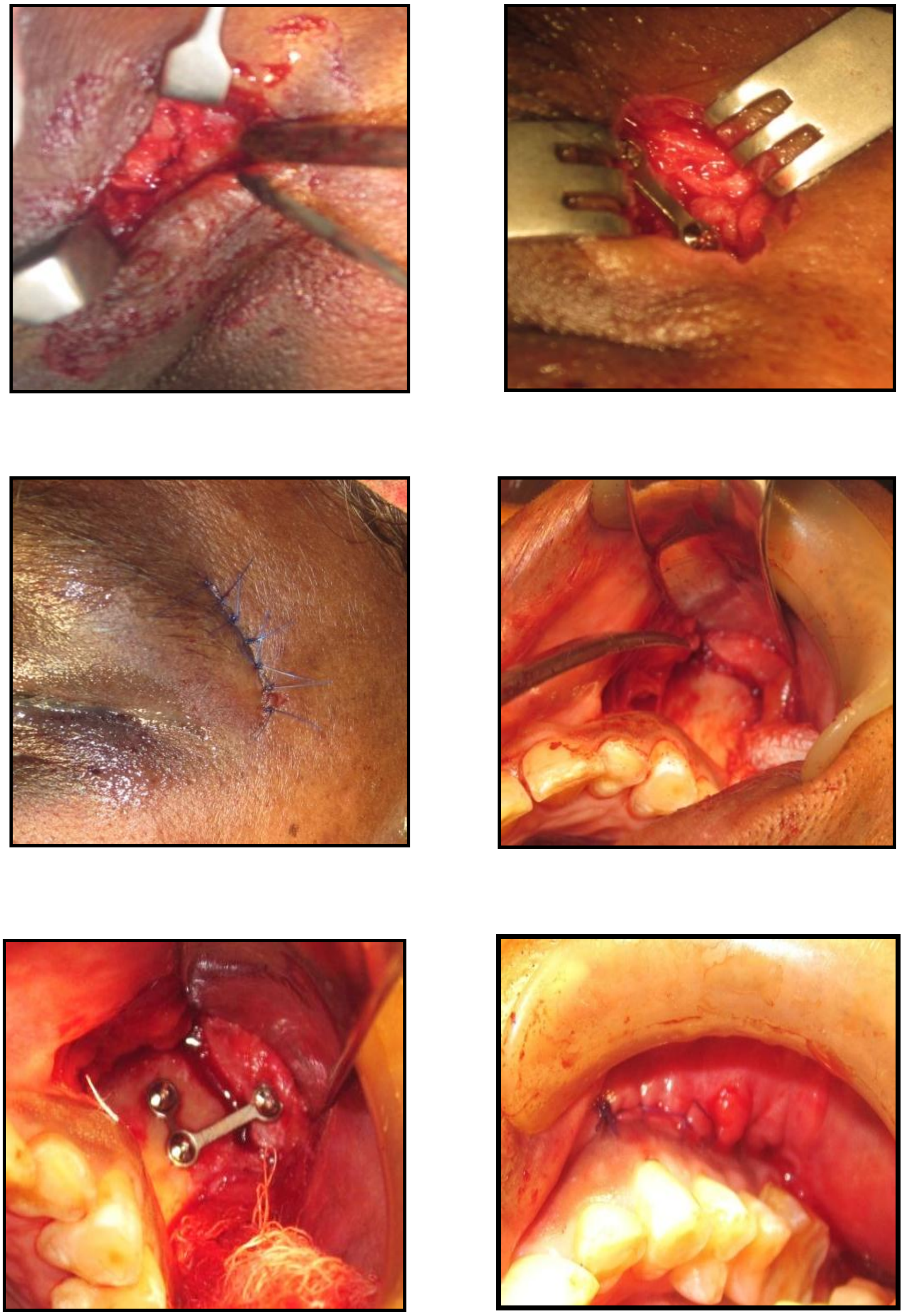


**Fig.33: INTRA OPERATIVE PHOTOGRAPHS**

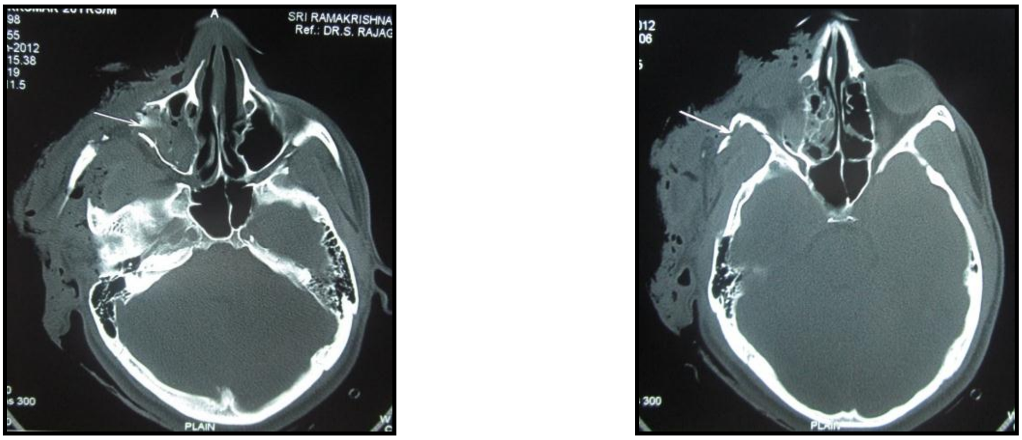
**Fig.34: TRACING – IMMEDIATE POST OPERATIVE RADIOGRAPHS**

**Fig.35: TRACING – 5TH WEEK POST OPERATIVE RADIOGRAPHS**

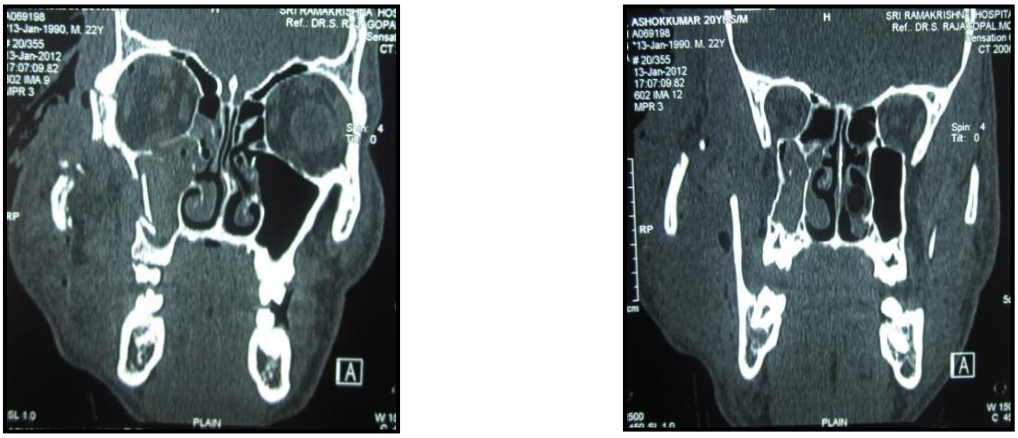
**Fig.36: POST OPERATIVE PHOTOGRAPHS**

# TYPE C FRACTURE – DIRECT REDUCTION AND THREE POINTS FIXATION WITH MINIPLATES (FZ + ZMB) AND TRANSOSSEOUS WIRING (ZYG. ARCH)

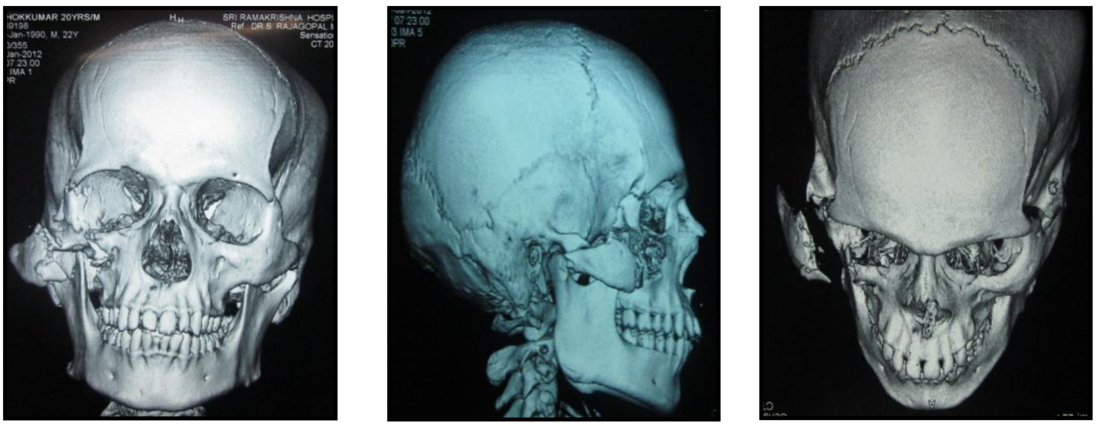
**Fig.37: PRE OPERATIVE PHOTOGRAPHS**




**AXIAL VIEWS**




**CORONAL VIEW**




**3D VIEWS**

**Fig.38: PRE OPERATIVE CT SCANS**

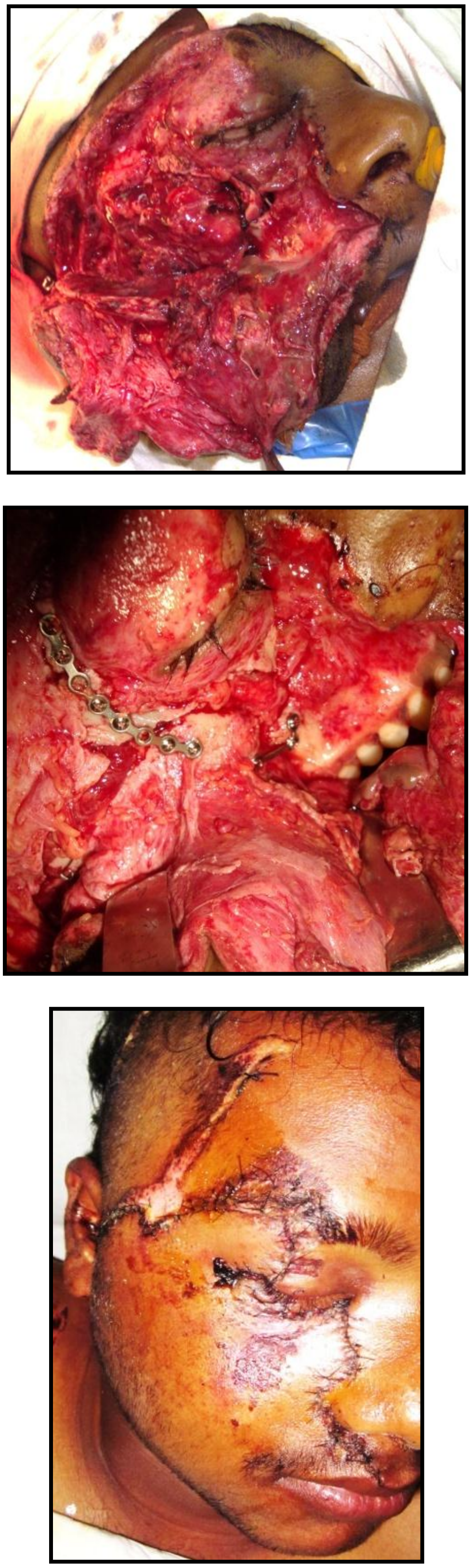


**Fig.39: INTRA OPERATIVE PICTURES**

**Fig.40: TRACING – IMMEDIATE POST OPERATIVE RADIOGRAPHS**


**Fig.41: TRACING – 5TH WEEK POST OPERATIVE RADIOGRAPHS**

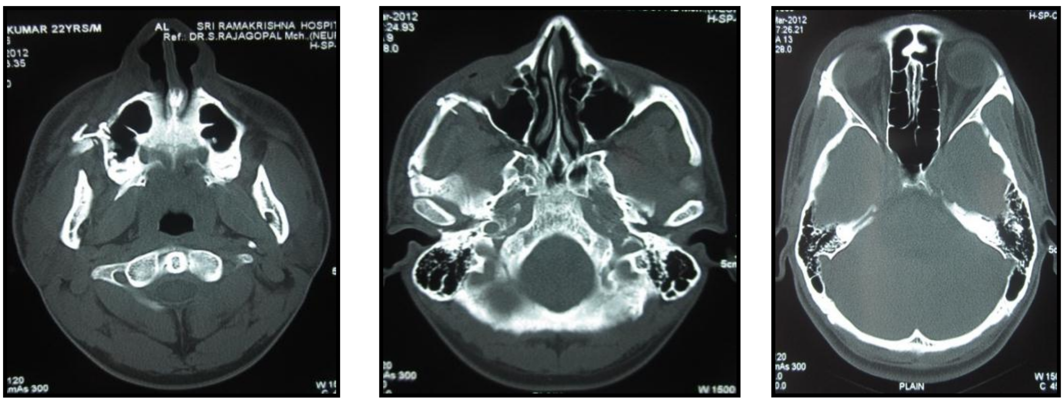



**Fig.42: POST OPERATIVE CT SCANS**

**Fig.43: POST OPERATIVE PHOTOGRAPHS**

# RESULTS

Over the two years period from December 2010 to June 2012, the records of our 32 patients with zygomatic complex fractures treated by various surgical treatment modalities in our Department of Oral and Maxillofacial Surgery, Sri Ramakrishna Dental College and Hospital, Coimbatore were available for analysis.

Of these 32 cases, patients with Lefort fractures or bilateral zygomatic complex fractures were excluded and so the number of patients were 26. When patients who were medically unfit for surgery within one week and patients who wanted discharge against medical advice were excluded, the number of patients came down to 22.

The sample included 22 males (100%), with mean age of 42 (Standard deviation: 17.57) [Table 1]. Road traffic accidents accounted for 86.4 % of fractures, followed by assault (9.1%) and work injury (4.5%) [Table 2]. The percentage of right or left side of the Zygomatic complex fractures was 68.2% and 31.8% [Table 3]. Four patients (18.18%) had associated mandible fractures which were symphysis, parasymphysis, condyle and body of mandible respectively. One patient had an associated mid palatal fracture (0.045%) and another had nasal bone fracture (0.045%) [Table 4]. Zygomatic fractures included in the study were classified according to ***Markus Zingg***[51] as

7 cases of Type A (31.81%), 8 cases of Type B (36.36%) and 7 cases of Type C (31.81%) [Table 5].

Treatment varied from reduction without fixation to open reduction with 3 point fixation. Reduction of all cases was accomplished by Upper buccal sulcus/ Keen's approach.

4 out of 22 cases (18.18%) were treated by indirect surgical reduction. The other 18 cases (81.81%) were treated with direct reduction and fixation of ZMC.

Various surgical approaches were applied in our 18 cases that had open reduction and fixation. The most commonly used approach was upper buccal sulcus approach (vestibular incision) of Zygomatic maxillary buttress (n=19). The lateral eyebrow approach (crowfoot incision) was the next commonly used approach to access the FZ region (n=13), followed by infraorbital approach to access the infraorbital rim (n=3).

We experienced a wide variation on points and location of fixation for Zygomatic complex fractures. 7 cases had one point fixation (31.81%), 8 cases had 2 point fixation (36.36%) and 3 cases had 3 point fixation (13.63%). Zygomatico maxillary buttress was the most frequent point of fixation being used in 15 cases (83.33%) that had fixation. The Fronto zygomatic suture was stabilized in 13 cases (72.22%) and infra orbital rim was stabilized in 3 cases (16.66%).

Bone plates used were all made up of titanium of size 1.3mm to 1.5mm. The 1.3mm (micro) plates were fixed with 1.3 x 6mm screws and 1.5mm (mid) plates with 1.5 x 6mm screws. The FZ suture area used 2 or 4 hole micro/mid plates with gap that was fixed with 1.3/ 1.5 x 6mm screws. The IO rim used 4 hole / 6 hole orbital plate (1.5mm) that was fixed with 1.5 x 6mm screws. The ZMB was fixed with L- shaped plate (1.5mm) and fixed with 1.5 x 6mm screws.

2 cases had wiring; one was at FZ and the other at Zygomatic arch.

**Adequacy of reduction:**

By following the criteria set forth in the materials and methods section, immediate postoperative plain radiographs (PNS & SMV) of 3 patients (13.63%) showed misalignments greater than 2mm. The individual cases are described in Table No. 8. This included one case of IO rim lateral segment inferiorly displaced by 2.5mm and medial collapse of arch, the second case of IO rim lateral segment inferiorly displaced by 3mm and the third case of malar prominence posteriorly displaced by 5mm and laterally bowed arch. In all the other cases, the ZMC was well positioned, at least within the limits of the assessment criteria used.

**Adequacy of fixation:**

All our 18 patients had a good quality plain radiographs that was taken at the $5^{th}$ postoperative week. In 3 patients (16.66%) there was a measurable loss in stability, which included lateral wall separation by 3mm in one case and malar projection posteriorly displaced by 4mm combined with lateral orbital wall separation by 3mm in the second case and IO rim lateral segment inferiorly displaced by 4mm and medial collapse of the arch in the third case.

**Associated complications:**

The facial photographs were assessed for the complications that occurred as a result of the surgical procedure. Ectropion and increased scleral show by 1mm was seen in one patient with Type C fracture in which the fracture site was exposed using the existing laceration. One patient had infected plate removal done at the $2^{nd}$ postoperative month. The incisions placed over the lateral eyebrow, upper buccal sulcus and infra orbital region healed well without any obvious scar formation, with best results in upper buccal sulcus incision.

**Mouth opening:**

Three of the patients developed transient postoperative trismus that improved gradually on long term follow up. All those patients who had restricted mouth opening preoperatively had marked improvement immediately after surgery and attained full mouth opening at the $5^{th}$ postoperative week.

**Infra orbital nerve paresthesia:**

Out of our 22 patients who presented with infra orbital paresthesia following trauma, all of them fully recovered sensation following surgery, out of which 3 cases had an altered sensation in the infraorbital region immediately following surgery which also recovered within the $5^{th}$ postoperative week.

**Facial symmetry:**

Majority of our patients had normal facial symmetry following surgery, except for four patients who had observable asymmetry on the injured side of the face characterized by malar flattening in three cases and widening of face in one case.

## Table 1: DISTRIBUTION OF PATIENT AMONG AGE GROUP

**Age**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Less than 30 years | 8 | 36.4 | 36.4 | 36.4 |
| | 31 - 40 years | 3 | 13.6 | 13.6 | 50.0 |
| | 41 - 50 years | 3 | 13.6 | 13.6 | 63.6 |
| | 51 - 60 years | 3 | 13.6 | 13.6 | 77.3 |
| | 61 - 70 years | 4 | 18.2 | 18.2 | 95.5 |
| | Above 70 years | 1 | 4.5 | 4.5 | 100.0 |
| | Total | 22 | 100.0 | 100.0 | |

**Report**

Age

| Age | Mean | N | Std. Deviation |
|---|---|---|---|
| Less than 30 years | 25.0000 | 8 | 4.24264 |
| 31 - 40 years | 35.0000 | 3 | 1.00000 |
| 41 - 50 years | 44.3333 | 3 | 2.30940 |
| 51 - 60 years | 54.6667 | 3 | 2.51661 |
| 61 - 70 years | 66.5000 | 4 | 3.10913 |
| Above 70 years | 73.0000 | 1 | . |
| Total | 42.7727 | 22 | 17.57415 |

## Table 2: DISTRIBUTION OF PATIENTS ACCORDING TO CAUSE OF INJURY

**Cause of Injury**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Road Traffic Accident | 19 | 86.4 | 86.4 | 86.4 |
| | Assault | 2 | 9.1 | 9.1 | 95.5 |
| | Work Injury | 1 | 4.5 | 4.5 | 100.0 |
| | Total | 22 | 100.0 | 100.0 | |

## Table 3: DISTRIBUTION OF ZYGOMATIC COMPLEX FRACTURE SITES

**Zygomatic Complex Fracture sites**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Right | 15 | 68.2 | 68.2 | 68.2 |
| | Left | 7 | 31.8 | 31.8 | 100.0 |
| | Total | 22 | 100.0 | 100.0 | |

## Table 4: PRESENCE OF ASSOCIATED FACIAL FRACTURES

| **Associated fracture sites** | **Number of patients** |
|---|---|
| Mid Palatal fracture | 01 |
| Mandible fractures: | |
| (a) Symphysis | 01 |
| (b) Parasymphysis | 01 |
| (c) Condyle | 01 |
| (d) Body of mandible | 01 |
| Nasal bone fracture | 01 |
| TOTAL | 06 |

## TABLE 5: CLASSIFICATION OF ZYGOMATIC FRACTURES AND THEIR TREATMENT MODALITY

**Markuss Zing Classification**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Type A | 7 | 31.8 | 31.8 | 31.8 |
| | Type B | 8 | 36.4 | 36.4 | 68.2 |
| | Type C | 7 | 31.8 | 31.8 | 100.0 |
| | Total | 22 | 100.0 | 100.0 | |

# STATISTICAL EVALUATION OF DATA

| | | | Reduction without fixation | One point fixation | Two point fixation | Three point fixation | Total |
|---|---|---|---|---|---|---|---|
| Markus Zing classification | Type A | Count | 4 | 3 | 0 | 0 | 7 |
| | | % within Markus Zingg classification | 57.1% | 42.9% | .0% | .0% | 100.0% |
| | | % within treatment modality | 100.0% | 42.9% | .0% | .0% | 31.8% |
| | Type B | Count | 0 | 4 | 4 | 0 | 8 |
| | | % within Markus Zingg classification | .0% | 50.0% | 50.0% | .0% | 100.0% |
| | | % within treatment modality | .0% | 57.1% | 50.0% | .0% | 36.4% |
| | Type C | Count | 0 | 0 | 4 | 3 | 7 |
| | | % within Markus zing classification | .0% | .0% | 57.1% | 42.9 % | 100.0% |
| | | % within treatment modality | .0% | .0% | 50.0% | 100.0% | 31.8% |
| Total | | Count | 4 | 7 | 8 | 3 | 22 |
| | | % within Markus zing classification | 18.2% | 31.8% | 36.4% | 13.6 % | 100.0% |
| | | % within treatment modality | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 22.112[a] | 6 | .001 |
| Likelihood Ratio | 27.598 | 6 | .000 |
| Linear-by-Linear Association | 15.112 | 1 | .000 |
| N of Valid Cases | 22 | | |

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is .95.

## TABLE 6: PRE OPERATIVE EVALUATION

| S.No | Name | Age /Sex | Diagnosis & Classification | Mouth Opening | Infraorbital Nerve paresthesia | Facial asymmetry | Follow up period |
|---|---|---|---|---|---|---|---|
| 1 | Mr. Ravikumar | 20/M | R ZMC # (Type A) | Normal | Present | Present | 3 months |
| 2 | Mr. Palanisamy | 63/M | L ZMC # (Type A) | Restricted | Present | Present | 6 months |
| 3 | Mr. Subramanian | 70/M | R ZMC # (Type B) | Restricted | Present | Present | 6 months |
| 4 | Mr. Mariappan | 36/M | R ZMC # (Type A) | Restricted | Present | Absent | 6 months |
| 5 | Mr. Suresh | 52/M | R ZMC # (Type B) | Restricted | Present | Present | 3 months |
| 6 | Mr. Chinnasamy | 35/M | R ZMC # (Type B) | Restricted | Present | Present | 6 months |
| 7 | Mr. Karrupusamy | 28/M | L ZMC # (Type B) | Restricted | Absent | Absent | 6 months |
| 8 | Mr. Sivaraman | 24/M | R ZMC # (Type C) | Restricted | Present | Present | 6 months |
| 9 | Mr. Mohammed Rafique | 20/M | R ZMC # (Type B) | Restricted | Present | Present | 6 months |
| 10 | Mr. Selvaraj | 47/M | L ZMC # (Type B) | Restricted | Present | Present | 3 months |
| 11 | Mr. Kathiresan | 34/M | R ZMC # (Type B) | Restricted | Present | Present | 3 months |
| 12 | Mr. Kumar | 38/M | L ZMC # (Type B) | Restricted | Present | Present | 3 months |
| 13 | Mr. Suresh kumar | 29/M | L ZMC # (Type C) | Restricted | Present | Present | 3 months |
| 14 | Mr. Sri Rangan | 65/M | L ZMC # (Type C) | Restricted | Present | Present | 6 months |
| 15 | Mr. Palaniappan | 73/M | R ZMC # (Type C) | Restricted | Present | Present | 1 year |
| 16 | Mr. Palanisamy.J | 28/M | R ZMC # (Type C) | Restricted | Present | Present | 3 months |
| 17 | Mr. Murugan | 30/M | R ZMC # (Type C) | Restricted | Present | Present | 1 year |
| 18 | Mr. Ashok kumar | 21/M | R ZMC # (Type C) | Restricted | Present | Present | 1 year |
| 19 | Mr. Balasubramanian | 43/M | L ZMC # (Type A) | Restricted | Absent | Absent | 3 months |
| 20 | Mr. Shanmugha sundaram | 43/M | R Zyg. Arch # (Type A) | Restricted | Absent | Present | 3 months |
| 21 | Mr. Duraisamy | 55/M | R Zyg. Arch # (Type A) | Restricted | Absent | Present | 5 weeks |
| 22 | Mr. Varadharaj | 57/M | R ZMC # (Type A) | Restricted | Absent | Absent | 5 weeks |

## Table 7: POST OPERATIVE EVALUATION

| S.No | Name | Diagnosis & Classification | Treatment given | Mouth Opening | IO Parasthesia | Facial Symmetry | Complications |
|---|---|---|---|---|---|---|---|
| 1 | Mr. Ravikumar | R ZMC # (Type A) | Elevation with 1 Point (ZMB) Fixation | Normal | Absent | Normal | Nil |
| 2 | Mr. Palanisamy | L ZMC # (Type A) | | Normal | Absent | Normal | Nil |
| 3 | Mr. Subramanian | R ZMC # (Type B) | | Normal | Absent | Normal | Nil |
| 4 | Mr. Mariappan | R ZMC # (Type A) | | Normal | Absent | Normal | Nil |
| 5 | Mr. Suresh | R ZMC # (Type B) | | Normal | Absent | Malar Flattening | Nil |
| 6 | Mr. Chinnasamy | R ZMC # (Type B) | Elevation with 1 Point (FZ) fixation | Normal | Absent | Normal | Nil |
| 7 | Mr. Karrupusamy | L ZMC # (Type B) | | Normal | Absent | Malar Flattening | Nil |
| 8 | Mr. Sivaraman | R ZMC # (Type C) | | Normal | Absent | Normal | Transient Trismus |
| 9 | Mr. Mohammed Rafique | R ZMC # (Type B) | Elevation with 2 Point (FZ + ZMB) fixation | Normal | Absent | Normal | Nil |
| 10 | Mr. Selvaraj | L ZMC # (Type B) | | Normal | Absent | Normal | Nil |
| 11 | Mr. Kathiresan | R ZMC # (Type B) | | Normal | Absent | Normal | Nil |
| 12 | Mr. Kumar | L ZMC # (Type B) | | Normal | Absent | Normal | Nil |
| 13 | Mr. Suresh kumar | L ZMC # (Type C) | | Normal | Absent | Normal | Nil |
| 14 | Mr. Sri Rangan | L ZMC # (Type C) | | Normal | Absent | Normal | Nil |
| 15 | Mr. Palaniappan | R ZMC # (Type C) | Elevation with 2 Point (FZ + IOR) fixation | Normal | Absent | Normal | Infected plate at FZ region |
| 16 | Mr. Palanisamy.J | R ZMC # (Type C) | Elevation with 3 Point (FZ + ZMB + IOR) fixation | Normal | Absent | Normal | Transient Trismus |
| 17 | Mr. Murugan | R ZMC # (Type C) | | Normal | Absent | Normal | Nil |
| 18 | Mr. Ashok kumar | R ZMC # (Type C) | Elevation with 3 Point (FZ + ZMB + ZA) | Normal | Absent | Malar Flattening | Transient Trismus Ectropion Increased scleral show (1mm) |
| 19 | Mr. Balasubramanian | L ZMC # (Type A) | Indirect Reduction with no Fixation | Normal | Absent | Widening of face | Nil |
| 20 | Mr. Shanmugha sundaram | R Zyg. Arch # (Type A) | | Normal | Absent | Normal | Nil |
| 21 | Mr. Duraisamy | R Zyg. Arch # (Type A) | | Normal | Absent | Normal | Nil |
| 22 | Mr. Varadharaj | R ZMC # (Type A) | | Normal | Absent | Normal | Nil |

# STATISTICAL ANALYSIS OF DATA

## MOUTH OPENING GROUP:

| | | | Group | | |
|---|---|---|---|---|---|
| | | | Pre | Post | Total |
| Mouth Opening | Normal | Count | 1 | 22 | 23 |
| | | % within Mouth Opening | 4.3% | 95.7% | 100.0% |
| | | % within Group | 4.5% | 100.0% | 52.3% |
| | Restricted | Count | 21 | 0 | 21 |
| | | % within Mouth Opening | 100.0% | .0% | 100.0% |
| | | % within Group | 95.5% | .0% | 47.7% |
| Total | | Count | 22 | 22 | 44 |
| | | % within Mouth Opening | 50.0% | 50.0% | 100.0% |
| | | % within Group | 100.0% | 100.0% | 100.0% |

## INFRAORBITAL PARAESTHESIA GROUP:

| | | | Group | | |
|---|---|---|---|---|---|
| | | | Pre | Post | Total |
| Infraorbital Nerve Parasthesia | Absent | Count | 5 | 22 | 27 |
| | | % within Infraorbital Nerve Parasthesia | 18.5% | 81.5% | 100.0% |
| | | % within Group | 22.7% | 100.0% | 61.4% |
| | Present | Count | 17 | 0 | 17 |
| | | % within Infraorbital Nerve Parasthesia | 100.0% | .0% | 100.0% |
| | | % within Group | 77.3% | .0% | 38.6% |
| Total | | Count | 22 | 22 | 44 |
| | | % within Infraorbital Nerve Parasthesia | 50.0% | 50.0% | 100.0% |
| | | % within Group | 100.0% | 100.0% | 100.0% |

## FACIAL ASYMMETRY GROUP:

**Crosstab**

| | | | Group | | |
|---|---|---|---|---|---|
| | | | Pre | Post | Total |
| Facial Asymmetry | Absent | Countt | 4 | 18 | 22 |
| | | % within Facial Asymmetry | 17.4% | 82.6% | 100.0% |
| | | % within Group | 18.2% | 86.4% | 52.3% |
| | Present | Count | 18 | 4 | 22 |
| | | % within Facial Asymmetry | 85.7% | 14.3% | 100.0% |
| | | % within Group | 81.8% | 18.18% | 47.7% |
| Total | | Countt | 22 | 22 | 44 |
| | | % within Facial Asymmetry | 50.0% | 50.0% | 100.0% |
| | | % within Group | 100.0% | 100.0% | 100.0% |

## TABLE 8: ADEQUACY OF REDUCTION

| S. NO | Name | Surgical Access | Fixation Points | Measurement of Immediate Post-operative radiographs and comparison with uninjured side | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Water's view | | | Submentovertex view | |
| | | | | Orbital width | IO rim & FZ suture | Contour of ZMB | Malar Projection | Contour of Zygomatic Arch |
| 1 | Mr. Ravikumar | ZMB | ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 2 | Mr. Palanisamy | ZMB | ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 3 | Mr. Subramanian | ZMB | ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 4 | Mr. Mariappan | ZMB | ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 5 | Mr. Suresh | ZMB | ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 6 | Mr. Chinnasamy | FZ | FZ | Equal | Continuous | Aligned | Equal | Normal |
| 7 | Mr. Karrupusamy | FZ | FZ | Equal | Continuous | Aligned | Equal | Normal |
| 8 | Mr. Sivaraman | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 9 | Mr. Mohammed Rafique | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 10 | Mr. Selvaraj | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 11 | Mr. Kathiresan | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 12 | Mr. Kumar | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 13 | Mr. Suresh kumar | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 14 | Mr. Sri Rangan | FZ + ZMB | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 15 | Mr. Palaniappan | FZ + IO | FZ + IO | Equal | Continuous | Aligned | Equal | Normal |
| 16 | Mr. Palanisamy.J | FZ + IO + ZMB | FZ + IO + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 17 | Mr. Murugan | FZ + IO + ZMB | FZ + IO + ZMB | Equal | Continuous | Aligned | Equal | Normal |
| 18 | Mr.Ashok kumar | FZ + ZMB + ZA | FZ + ZMB + ZA | Increased by 3mm | IO rim lateral segment inferiorly displaced by 2.5mm. | Aligned | Equal | Medial Collapse. |
| 19 | Mr. Balasubramanian | Keen's | Nil | Increased by 2.5mm | IO rim lateral segment inferiorly displaced by 3mm | Aligned | Equal | Normal |
| 20 | Mr. Shanmugha sundaram | Keen's | Nil | Equal | Continuous | Aligned | Equal | Normal |
| 21 | Mr. Duraisamy | Keen's | Nil | Equal | Continuous | Aligned | Equal | Normal |
| 22 | Mr. Varadharaj | Keen's | Nil | Equal | Continuous | Aligned | Posteriorly displaced by 5mm | Laterally bowed |

## TABLE 9: ADEQUACY OF FIXATION

| S. No | Name | Fixation Points | Measurement of Immediate Post-operative radiographs and comparison with uninjured side | | | | | Associated complications |
|---|---|---|---|---|---|---|---|---|
| | | | Water's view | | | Submentovertex view | | |
| | | | Orbital width | IO rim & FZ suture | Contour of ZMB | Malar Projection | Contour of Zygomatic Arch | |
| 1 | Mr. Ravikumar | ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 2 | Mr. Palanisamy | ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 3 | Mr. Subramanian | ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 4 | Mr. Mariappan | ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 5 | Mr. Suresh | ZMB | Increased by 2.5mm | Lateral orbital wall separation by 3mm | Aligned | Equal | Normal | Malar flattening |
| 6 | Mr. Chinnasamy | FZ | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 7 | Mr. Karrupusamy | FZ | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 8 | Mr. Sivaraman | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 9 | Mr. Mohammed Rafique | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 10 | Mr. Selvaraj | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 11 | Mr. Kathiresan | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 12 | Mr. Kumar | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 13 | Mr. Suresh kumar | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 14 | Mr. Sri Rangan | FZ + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 15 | Mr. Palaniappan | FZ + IO | Increased by 2.5mm | Lateral orbital wall separation by 3mm. | Aligned | Posteriorly displaced by 4mm | Normal | Malar flattening. Transient trismus. Infected plate at FZ region |
| 16 | Mr. Palanisamy.J | FZ + IO + ZMB | Equal | Continuous | Aligned | Equal | Normal | Transient trismus |
| 17 | Mr. Murugan | FZ + IO + ZMB | Equal | Continuous | Aligned | Equal | Normal | Nil |
| 18 | Mr. Ashok kumar | FZ + ZMB + ZA | Increased by 3mm | IO rim lateral segment inferiorly displaced by 4mm. | Aligned | Normal | Medial Collapse. | Malar flattening. Widening of face. Ectropion. Increased scleral show by 1mm. |

## TABLE 10: INADEQUATE REDUCTION

| S. No | Name | Surgical Access | Deformity | Apparent in long term facial photographs |
|---|---|---|---|---|
| 1. | Mr. Ashok Kumar | FZ + ZMB + ZA (Keens') | IO rim lateral segment inferiorly displaced by 2.5mm. Medial collapse of the arch. | Malar flattening. Widening of face. Ectropion. Increased scleral show by 1mm. |
| 2. | Mr. Balasubramanian | Keen's | IO rim lateral segment inferiorly placed by 3mm. | No |
| 3. | Mr. Varadharaj | Keen's | Malar prominence posteriorly displaced by 5mm. Laterally bowed arch. | No |

**Adequacy of Reduction**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Adequate | 19 | 86.4 | 86.4 | 86.4 |
| | In adequate | 3 | 13.6 | 13.6 | 100.0 |
| | Total | 22 | 100.0 | 100.0 | |

**TABLE 11: INADEQUATE FIXATION**

| S. No | Name | Fixation points | Deformity | Apparent in long term facial photographs |
|---|---|---|---|---|
| 1. | Mr. Suresh | ZMB | Lateral wall separation by 3mm | Malar flattening. |
| 2. | Mr. Palaniappan | FZ + IO | Lateral orbital wall separation by 3mm. Malar projection posteriorly displaced by 4mm. | Malar flattening. |
| 3. | Mr. Ashok Kumar | FZ + ZMB +ZA | IO rim lateral segment inferiorly displaced by 4mm. Medial collapse of the arch. | Malar flattening. Widening of face. Ectropion. Increased scleral show by 1mm. |

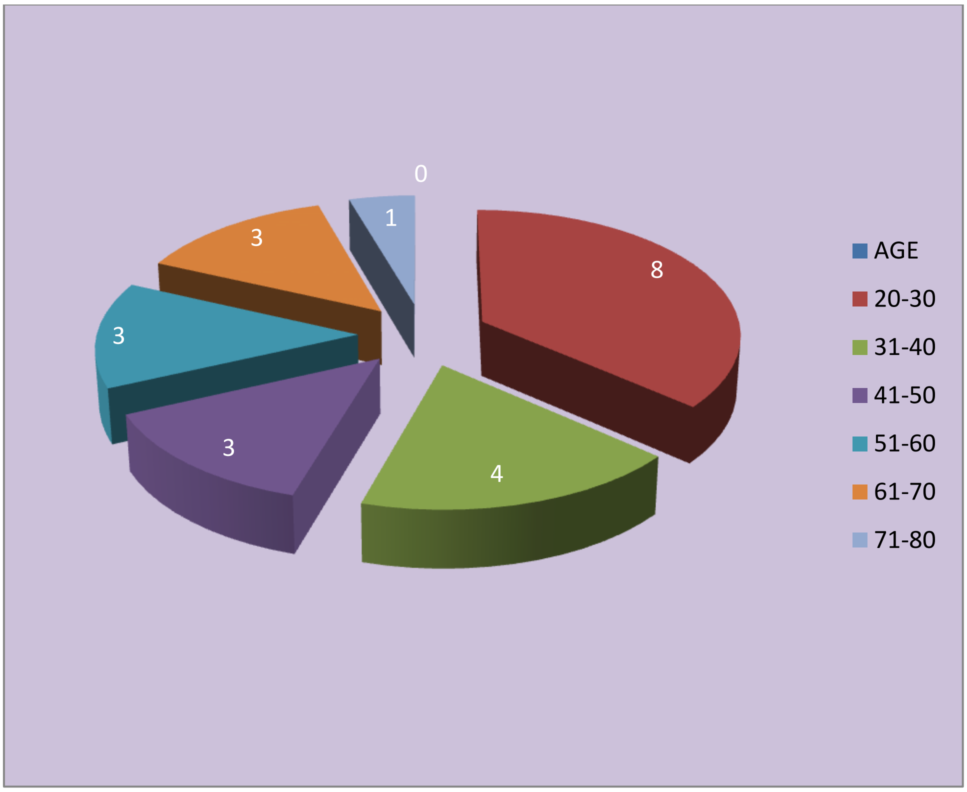
**Adequacy of fixation**

| | | Frequency | Valid Percent |
|---|---|---|---|
| Valid | Adequate | 15 | 83.33 |
| | In adequate | 3 | 16.66 |
| | Total | 18 | 100.0 |

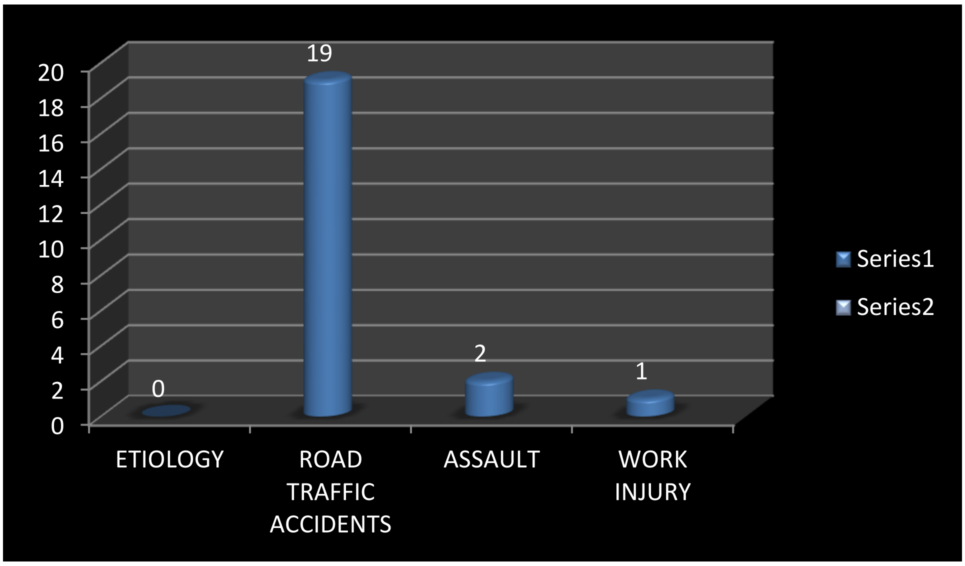
# TABLE 12: RESULTS

| | Indirect reduction without fixation | Direct reduction with one point fixation | Direct reduction with two point fixation | Direct reduction with three point fixation | Total | Inadequate reduction |
|---|---|---|---|---|---|---|
| No. of cases | 4 (18.18%) | 7 (31.81%) | 8 (36.36%) | 3 (13.63%) | 22 | 3 |
| Upper buccal sulcus approach | 4 | 5 | 7 | 3 | 19 (86.36%) | 3 |
| Lateral eyebrow approach | 0 | 2 | 8 | 3 | 13 (59.09%) | 0 |
| Infra orbital approach | 0 | 0 | 1 | 2 | 3 (13.63%) | 0 |
| Inadequate stability | | 1 (14.28%) | 1 (12.5%) | 1 (33.33%) | 3 (16.66%) | 0 |
| Facial symmetry in photograph | Normal in all. Widening of face in one. | Normal in all. Malar flattening in one. | Normal in all. Malar flattening in one. | Normal in all. Ectropion and increased scleral show by 1mm in one. Malar flattening in one. | - | - |

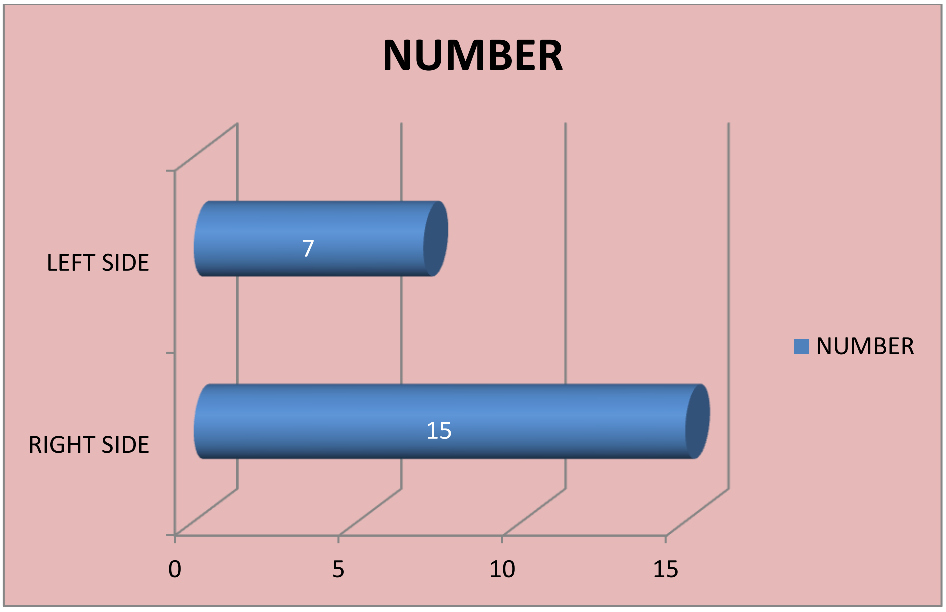
**Graph 1: AGE DISTRIBUTION**



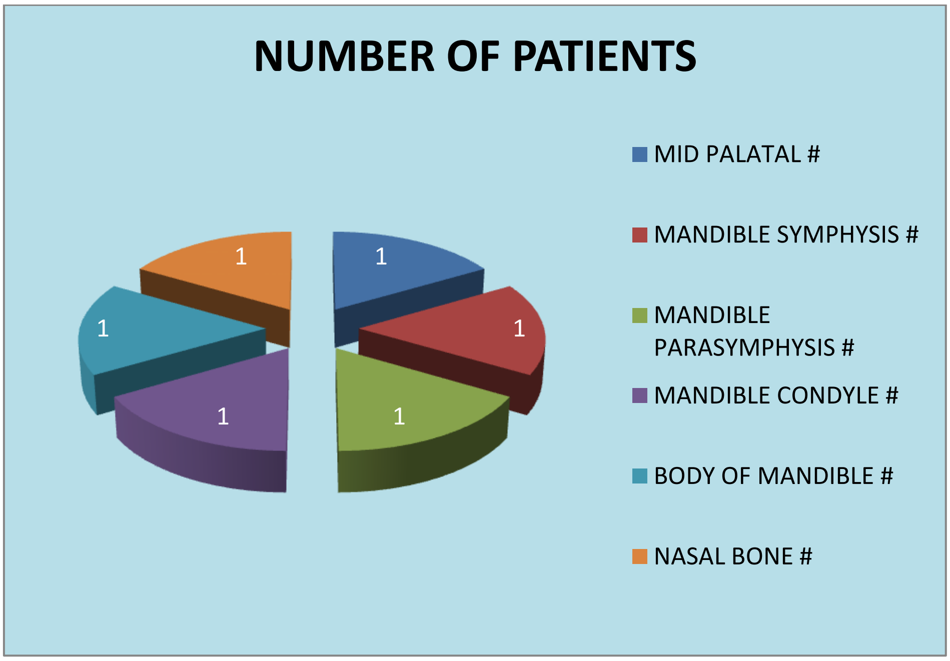

**Graph 2: ETIOLOGY OF INJURY**



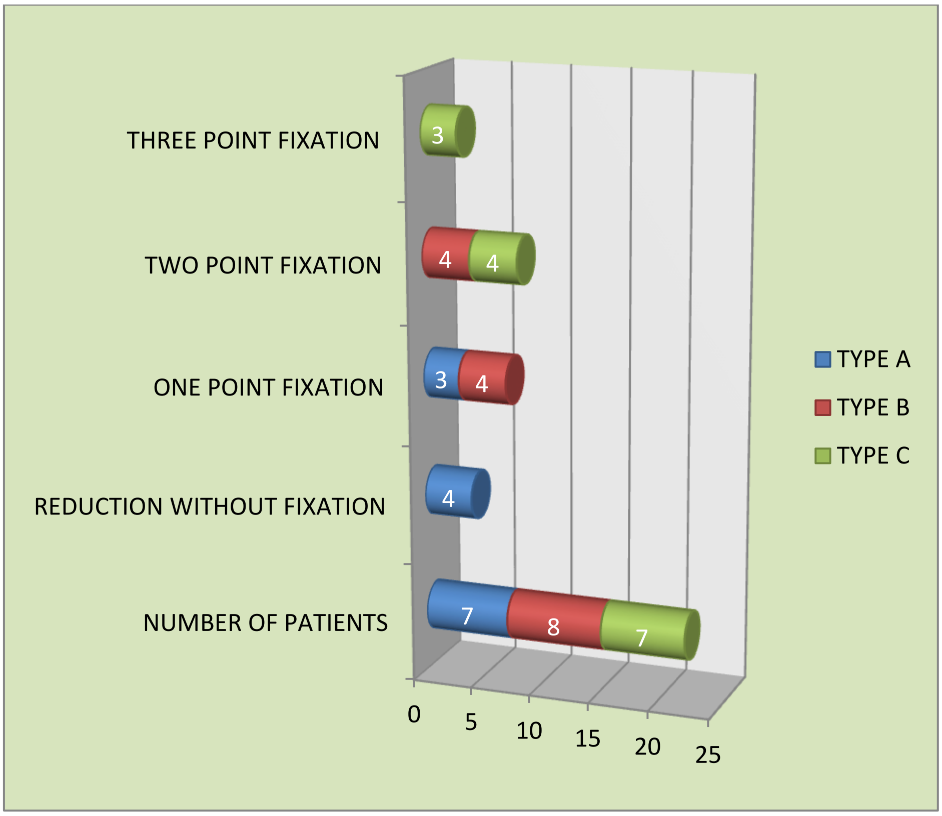
**Graph 3: FRACTURE SITES**




**Graph 4: ASSOCIATED FRACTURE SITES**



**Graph 5: CLASSIFICATION OF ZYGOMATIC FRACTURES & ITS TREATMENT MODALITY (ACCORDING TO MARKUS ZINGG)**



# DISCUSSION

The four most important considerations in treating ZMC fractures are proper reduction, adequate stabilization, adequate orbital reconstruction (when necessary) and adequate handling and positioning of periorbital soft tissues.[18] Because this study suffers from the same problems as most retrospective investigations, including a limited sample size, uncontrolled variables, inconsistent data accumulation, and lack of availability of records, it does not answer all questions concerning treatment of ZMC fractures. However, it does provide some valuable information on few specifics of treatment.

**Adequacy of reduction:** The most important principle in treating fractures, especially those of the face, is proper reduction. If the bone is not placed in the correct position, stabilization becomes superfluous. Therefore, assessment of the fractures for adequacy of reduction seemed mandatory. **Ellis[18]** identified and emphasized that the computed tomography (CT) scan as the single best preoperative and postoperative assessment modality, which is considered to be the “Gold Standard”. In our study, CT Scans and plain radiographs were taken preoperatively, but only plain radiographs were used postoperatively. Recommendations in the literature for reduction of ZMC fractures range from indirect reduction without fixation, to 3 or 4 point surgical exposure, under general anesthesia or local anesthesia. **Schneider J.F.C. (1990)[73]** described a technique for reducing fractures of the zygomatic complex under local anesthesia. But in our study, that included 22 cases, all cases were operated under general anesthesia. **Zingg et al**[51] in reviewing 946 ZMC fractures treated by a variety of means, including 164 treated by" closed reduction", found a 13% incidence of malar asymmetry. In our study 4 patients treated by indirect method without fixation, 2 cases showed inadequate reduction, indicating the necessity for some form of open reduction and fixation. **Edward Ellis et al**[18] evaluated the adequacy of reduction and fixation of ZMC fractures treated by various methods and concluded that a variety of techniques may be used to produce a satisfactory outcome.

**Nicholas Zachariades et al**[57] evaluated the efficacy of current methods for the treatment of the ZMC and concluded that open reduction and semi rigid fixation with mini plates are the most reliable methods available. We too experienced the same result, but treatment also depends on the type / classification of ZMC fracture as described by **Markuss Zing,**[51] which was followed in our study. 3 of the 22 cases in the study were inadequately reduced as assessed from the images and radiographs taken immediately within 36 hours of surgery.

**Balasubramaniam**[2] proved that in the intra oral approach, the access to any point along the arch is quite satisfactory because the elevator easily swings along the inner aspect of the arch and there is no difficulty in bringing the fractured fragments into position, whether this involves the zygomatic mass as such or any part of the arch and ironing out comminuted fractures of the arch is also quite simple. In our study also, all the cases were reduced by upper buccal sulcus approach and results seemed to be satisfactory.

In all the 18 cases where fixation was provided, fixation was made with wires or bone plates or both. In case where transosseous wires were used for fixation, some amount of separation was seen between bone fragments, but within the limits of the criteria designed for the study (<2mm). This deformity or derangement was not apparent in the facial photographs. This indicates that some imprecision in reduction may be tolerable and clinically insignificant depending on the magnitude, location, and soft tissue masking of the fracture.

**Adequacy of fixation:** The number of fixations to prevent post-reduction displacement of the fracture ZMC is always one of the most controversial topics in maxillofacial trauma. Recommendations for fixation have varied from none, to the placement of 3 or 4 bone plates at different locations. The reason of this disparity is multi factorial and includes many tangible factors such as the type of injury being treated, i.e. Simple versus comminuted fractures, grossly displaced versus minimally displaced fractures etc. The classification / type of fractures also plays an important role in deciding the number of fixation sites sufficient to prevent displacement. According to the classification proposed by **Markus Zingg,**[51] our study comprised of 7 cases of Type A (Incomplete zygomatic complex fracture) – 31.81%, 8 cases of Type B (Tetrapod Fracture) – 36.36% and 7 cases of Type C (Multi fragment Zygoma fracture) – 31.81%. (Table 5).

The masseter muscle has often been implicated as a primary cause of post reduction displacement of the fractured ZMC. It is assumed to be capable of exerting sufficiently inferior directed force on the fractured zygoma to cause movement even after fixation with plates. However this contention has never been proved. A study by **Dal Santo et al**[10] compared masseter muscle force in 10 male controls with 10 male patients who had sustained unilateral ZMC fractures. It was found that masseter muscle develops significantly less force in patients with ZMC fracture than in controls. The results of this study cast doubt on the role of masseter muscle in post reduction displacement of the fractured ZMC and indicate that minimal amounts of fixation may be necessary for such injuries.

In our study which comprised of 22 patients, 18 cases were treated with open reduction and internal fixation. 7 cases had one point fixation (31.81%), 8 cases had 2 points fixation (36.36%) and 3 cases had 3 points fixation (13.63%).

The adequacy of fixation was evaluated by comparing the 5$^{th}$ post operative radiographs with the immediate post operative radiographs. On comparison, only 3 cases showed significant displacement, all other cases (n=15) were stable, in which the first case (Type B fracture) was treated with one point fixation (ZMB), the second case (Type C fracture) with two points of fixation (FZ + IO) and the third case (Type C fracture) with three points of fixation (FZ + ZMB + Zyg. Arch).

One point fixation was done in seven cases (3 cases of Type A fracture and 4 cases of Type B fracture). 2 cases had single point fixation at the FZ suture region and 5 cases at ZMB region alone. One case which had one point fixation at ZMB had lateral orbital wall separation by 3mm. This could have been prevented if fixation had been been done in FZ along with ZMB for Type B fractures. **Ian J.Jackson**[29] advocated the use of plates for complex comminuted ZMC fractures. **David W.Eisele**[13] described the use of a single new-mini dynamic compression plate system for single point stabilization of unstable ZMC fractures that frequently require stabilization at two points. In our study, ZMB was fixed with L-Shaped 4 hole plate with plates and 1.5mm x 6mm screws. FZ was fixed with 4 hole plate with gap using 1.5mm x 6 mm screws. Champy et al used a single bone plate at FZ region in 342 isolated ZMC fractures and found that only 6 (1.8%) had an unsatisfactory result.

Two point fixations were done in eight cases (4 cases Type B fracture and 4 cases Type C fracture). 7 cases had 2 point fixations at the FZ and ZMB region and 1 case at FZ and IO rim. All 7 cases had miniplate fixation at ZMB, while 6 cases had miniplate fixation at FZ and 1 case had wiring at FZ region. The cases fixed with wires showed some displacement of fracture segments but within limits of the study (<2mm), while bone plate offered good approximation. There was no displacement of the ZMC. The infra orbital rim was stabilized with 4 hole / 6 hole orbital plates and 1.5mm x 6mm screws. One case which had 2 points fixation at FZ and IO rim at 5$^{th}$ week postoperative radiograph showed lateral orbital wall separation by 3mm and malar projection posteriorly displaced by 4mm. Lateral orbital wall separation was due to the infected plate and screws at the region of FZ which was observed $5^{th}$ week post operatively and was later removed at $2^{nd}$ month post operatively and the displacement of the malar projection by 4mm could have been prevented by providing an additional fixation at ZMB as it was a Type C fracture.

Three point fixations were done in three cases (Type C fracture). 2 cases at the FZ, IO and ZMB and 1 case at FZ, ZMB and Zygomatic Arch. In both the cases at FZ, ZMB and IO rim all points were fixed with miniplates. No displacement of zygoma was noted at the immediate and 5 weeks postoperative radiographs. In 1 case with 3 point fixations at FZ, ZMB and Zygomatic Arch, FZ and ZMB were fixed with miniplates and wiring was done at Zygomatic Arch, which showed inadequate reduction in immediate post operative radiograph as medial collapse of the arch and the lateral segment of the infra orbital rim inferiorly displaced by 2.5mm which progressed to 4mm in the $5^{th}$ week postoperative radiographs, suggesting inadequate fixation. IO rim displacement could have been prevented by additional fixation with miniplates at IO region. Medial collapse of the arch proves that wiring is not a stable form of fixation.

**Robert. B. Stanley**[70] stated that traditional 3 point reduction may not restore proper projection of malar prominence of zygoma, if 2 of the 3 anterior points are comminuted. In such cases he suggested the reconstruction of the fourth point, the zygomatic arch, as this increases the accuracy of the multidimensional reconstruction. **Paul. M.Manson**[63] also advocated 2 or 3 point fixation for complex comminuted zygoma fractures. He advised $4^{th}$ point fixation in extreme lateral displacement or segmentation of arch. In our study, 3 points fixation with miniplates provided good reduction and stability of the zygoma.

This discussion should not be misconstrued as a justification for using less fixation hardware. To the contrary, we believe in using as much hardware as is necessary to stabilize a fracture. This may range from no fixation to three or four bone plates and should be based on the classification of the ZMC fracture and the surgical procedure used in its treatment. As the study is about unilateral isolated ZMC fractures, in such fractures, the zygomaticomaxillary buttress provides great mechanical advantage for stabilizing a ZMC fracture by the application of a bone plate. One plate can prevent medial rotation of the ZMC into the maxillary sinus. However, if the maxillary alveolus, the hemimaxilla, or the complete maxilla is unstable, a bone plate in this location will not provide support to the repositioned zygoma. In such instances, primary fixation of the frontozygomatic area will be necessary.[18]

**Surgical approaches and Associated complications: D.J. Courtney (1999)**[14] treated the fractures of ZMC through upper buccal sulcus approach and fixation with mini-plate and found the method to be safe, rapid and effective technique. In all our cases, the zygoma was elevated by Keen’s / Upper buccal sulcus approach. The zygomatic buttress was exposed through the upper vestibular incision. The resultant scar was well concealed and aesthetically pleasing.

**Paul. M. Manson**[62] suggested that in fracture zygoma, the lower and lateral orbital rims can be explored using a single eyelid incision with lateral canthus mobilization, but in our study the FZ and IO region were exposed separately.

The infra orbital rim was exposed through infra orbital incision and FZ through lateral eyebrow approach. Facial scar was the only complication encountered, but was very minimal. All of them had a skin-muscle flap dissection. The infra orbital rim was exposed in 3 out of the 18 patients in this study through infra orbital incision in 2 patients and through existing laceration in one case, which had ectropion and increased scleral show by 1mm (33.33%), which resolved on long term follow up of 1 year and did not require any corrective surgery. No other complications were encountered.

All of our patients who developed trismus after suffering a fracture of the zygomatic complex, attained full mouth opening post operatively. 3 of them developed transient trismus post-operatively, which recovered within 3 days post operatively.

One case treated with 2 point fixation at FZ and IO rim, had an infected plate removed at 2$^{nd}$ month in the region of FZ, reason being uncontrolled diabetes as a predisposing factor.

**J.G. Mc Gimpsey et al**[34] reported that persistent sensory disturbances was present in 45% of the people who were operated for fracture zygoma and no substantial difference in outcome was found between the surgical methods employed. This is contrary to what we experienced in our study. In 17 out of 22 cases who complained of infra-orbital paraesthesia, pre operatively, reported normal sensation after surgery, out of which 3 cases had an altered sensation in the infraorbital region immediately following surgery which also recovered within 5$^{th}$ week postoperative follow up.

# SUMMARY AND CONCLUSION

Our retrospective study was conducted on 22 patients treated for unilateral zygomatic complex fractures by various treatment modalities. All our cases had a preoperative Computed Tomography Scan and/or Para Nasal Sinus view and Submentovertex radiographs taken to confirm the fracture of the zygomatic complex. Our cases were treated by indirect and direct surgical reduction methods and fixation done at one (Zygomaticomaxillary Buttress or Frontozygomatic region), two (Frontozygomatic region and Infraorbital rim or Frontozygomatic region and Zygomaticomaxillary Buttress) or three (Frontozygomatic region, Infraorbital rim and Zygomaticomaxillary Buttress or Frontozygomatic region and Zygomaticomaxillary Buttress and Zygomatic Arch) points. The adequacy of reduction was assessed by taking immediate post-operative radiographs within 36 hours (Para Nasal Sinus view & Submentovertex view). Our cases had regular follow up clinically and radio graphically for a minimum period of 5 weeks. The radiographs taken at the 5$^{th}$ post-operative week were compared with the immediate post op radiographs to assess the stability. In total, 3 cases (13.63%) showed inadequate reduction, [1 case of direct reduction and 3 point fixation (Type C fracture) with miniplates at Frontozygomatic region & Zygomaticomaxillary Buttress and wiring at Zygomatic Arch 2 cases of indirect reduction without fixation (Type A fracture)] and 3 cases (16.66%) showed inadequate stability [first case (Type B fracture) with one point fixation, second case (Type C fracture) with

2 points fixation and the third case (Type C fracture) with three points fixation of which two points fixed with miniplates and one point with wires]. The rest of the cases (n=15, 83.33%) showed good reduction and stability. One case presented with ectropion and increased scleral show of 1mm post operatively, but did not require any corrective surgery and one case had infected plate removal in the region of Frontozygomatic region at the second postoperative month. All cases that presented with infra orbital paresthesia and reduced mouth opening after trauma were relieved of the symptoms post operatively.

Limitations of the study:

1. No standardization of plain radiographs.
2. Multiple operators were involved and this could influence the treatment outcome.
3. Limited sample size and minimum follow up.

On thorough analysis of data obtained from our study, the classification or type of the zygomatico-maxillary complex fracture plays an important role in deciding the treatment modality. Keen's or Upper buccal sulcus approach used was very effective in reducing the zygomatic complex fractures and it also avoids unsightly scars and gives better patient satisfaction. As far as the fixation methods are concerned, even in the fractures that are well aligned and stable after indirect reduction, some point of fixation is mandatory since there is always a risk of displacement post operatively. In the cases that had fixations at two or three points the stability was better and had good facial symmetry in the photographs and facial scarring was minimized by doing sub-cuticular suturing. Hence out of our experience, we recommend for:

- Type A fractures : Single point fixation at Zygomaticomaxillary Buttress region.
- Type B fractures : Two points fixation at Zygomaticomaxillary Buttress and Frontozygomatic region.
- Type C fractures : Three points fixation at Zygomaticomaxillary Buttress, Frontozygomatic region and Infraorbital region.

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